POWER

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Misrepresentation

This buyer-and-seller series has developed, among other things, some extremely interesting phases of buyer's psychology. Apparently it makes little difference whether the commodity is electric motors, oil engines, control instruments, boilers, turbines or whatnot, it is considered quite legitimate to visit the sins of the buyer upon the patient shoulders of the seller whenever they can be made to stick.

This is not always with the knowledge of the higher-ups in the buyer's organization. If they knew, they would probably be quick to condemn the practice. One of any number of such cases will illustrate the point.

A large industrial purchased electrical power equipment, including some costly insulating parts. Due to orders from the man in charge of the unloading, these were handled in a heavy lift that parted the sling and broke everything. Was a new order placed? It was not.

Shortly thereafter the seller was informed that the insulators had been "damaged in transportation" and was requested to replace them and to claim reimbursement from the railroad.

The seller was even told that the damaged crate had been destroyed and so was not available for inspection. Although these facts were learned from a member of the buyer's organization, they could not be used without endangering the informant's position. So the seller, in full knowledge of the imposition, replaced the shipment at his own expense and said nothing.

In common decency, purchasers should impartially examine into the facts and determine the guilt in the case before telling the vendor to replace damaged or broken parts.

EDITORIALS

Base Power Decisions on Facts

If business executives would lay less stress on the so-called "sixth sense" and more on the well-known five everybody would be better off.

The profit margins of 1928 and 1929 made spacious playgrounds for the snap-judgment artists of industry, many of whom acquired national reputations because of the Napoleonic speed and style of their edicts. But the Waterloos of 1930 and since have changed all that. The search today is not so much for men who look and talk like executives as for those who are such in their own right. And their first qualification, in an era when mistakes of omission or commission are often fatal, must be the ability and will to use their own five senses and those of their subordinates.

A power problem, involving investment and savings, is up for decision. As often as not that decision is made on an insufficient basis of fact. Sometimes the fault lies with the engineer. More often, we think, the front office insists on saying yes or no firmly and in complete ignorance of what it is all about.

For this there is no excuse. Power facts are obtainable. Steam and electricity can be measured. Prices and guarantees can be obtained. The whole power world is full of operating experience—on tap for the asking. Finally, there are plenty of men who know exactly how to assemble and analyze such facts.

Outage Time of Hydro-Electric Units

The seventh annual report on mechanical reliability of hydro-electric units was recently made available by the Hydraulic Power Committee of the National Electric Light Association. This report, like its precedessors, gives interesting data on hydro-electric units' reliability and causes of their outage. Records of two hundred and thirty units are included, with an aggregate capacity of nearly six million horsepower, or more than one-third of that installed in this country.

As in previous reports, outage time of the units is low, being less than four per cent of the total. A study of these reports for the last seven years does not reveal a distinct trend in the outage time. For the five years following 1925 there was apparent a trend downward, but 1930 showed a considerable increase. The latter was a drought year, and because of reduced output it might be expected this would have the effect of reducing outage time for repairs and overhauling. It may be, however, that because the units were idle, due to low water, advantage was taken of this condition to do more overhauling work. Undoubtedly, low water accounted for the low outage time, when in demand, of less than one-third of one per cent, almost one-third of that for the lowest previous year.

Waterwheels and their auxiliaries continue to be responsible for a major portion of the outage time. For propeller-type units over ninety-three per cent of the outage time is chargeable to hydraulic parts. This high percentage for the propeller-type unit is what might be expected, as the design is comparatively new and difficulties have occurred in operation. On the vertical reaction type units over fifty-six per cent of the outage time is chargeable to waterwheels and their auxiliaries. This figure is comparable with those in previous reports and indicates that the hydraulic end of these units continue to be a vulnerable spot.

The Internal-Combustion Boiler

Some years ago a Belgian engineer named Brunler developed a boiler in which the gas flame was submerged in the water. This idea has been further developed in England by Hammond and his burner is finding some commercial applications. The gas and air have to be compressed to a pressure higher than the boiler pressure. While the efficiency is high, two difficulties have arisen in its application to power generation. First, the power required to compress the gas and air takes an excessive portion of the gross output of the boiler and, secondly, the products of combustion mix with the steam and pass on to the engine or turbine, making it impossible to maintain a high vacuum. Hence the economy of such a plant, unless run non-condensing, is much reduced.

Announcement of the new Velox boiler by Brown Boveri, as described recently in *Power,* places another internal-combustion boiler before engineers. In this case the products of combustion do not mix with the steam produced. The air and gas are compressed and admitted to a combustion chamber under comparatively high pressure. The products of combustion still under high pressure pass at high velocity through tubes of small diameter where rates of heat transfer are said to be very high. After passing through an economizer, the cooled gases are expanded to a low temperature in a gas turbine which drives the necessary compressor. Thus the power demands of the compressor are taken care of independently of the boiler output.

If the present expectations of performance can be realized in units of commercial size, it may have an important effect on power house design, particularly where cheap natural gas and fuel oil are available.

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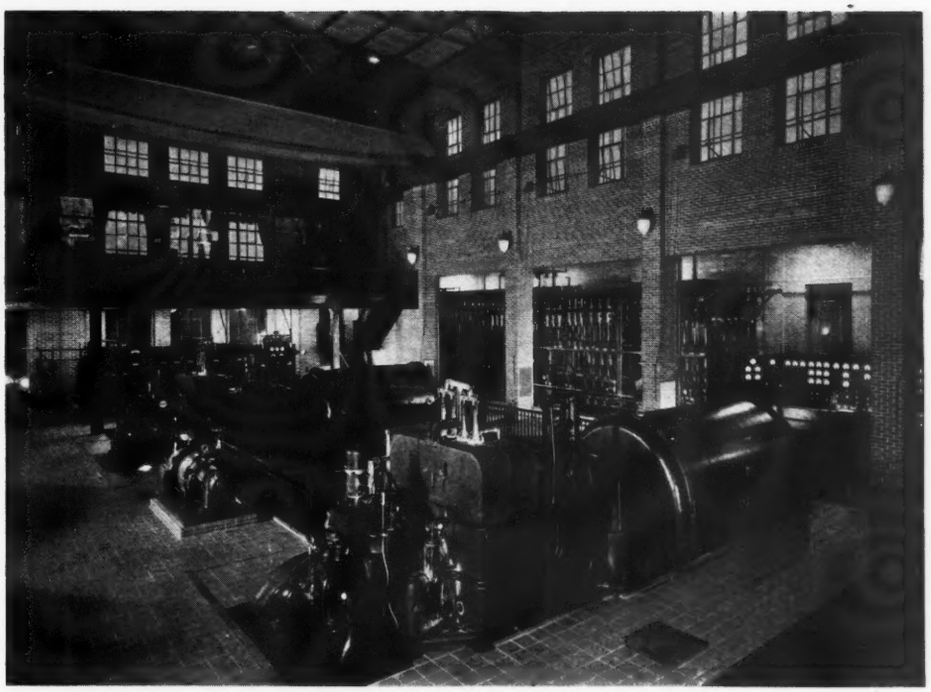
POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



Turbine room, K Street station, Lincoln, Neb., which bleeds steam for district heating and process

Put Plant Fuel Costs Where They Belong

By CLIFFORD C. ANDERSON

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All sorts of ideas exist as to how plant costs should be split between power and process steam in combination plants. The author discusses several commonly used methods and their faults. He also proposes one of his own which divides the savings between the two

TO ASSIGN fuel costs properly in a plant which generates electrical energy and supplies a process steam load by extraction from its turbines is essentially a difficult problem. The two divisions, which may be designated as electric generation and process steam departments, usually required separate cost accounting. The total plant fuel must, therefore, be apportioned. It may safely be stated that no rigidly fair and exact solution to this type of problem is known to exist.

Fuel cost is, of course, only a portion of the total expense involved in producing a pound of process steam or a kilowatt-hour of electrical energy. In addition to fuel costs, all operating and maintenance expenses as well as fixed charges on capital investments applying must be evaluated in determining the total costs of either commodity. The scope of this article, however, will be limited to the subject of fuel apportionments only, since, in this connection, there are a number of methods in common use which when applied give widely varying results. Some of the methods that usually result in unfair fuel apportionments will be described, after which a method will be outlined believed to be fundamentally fair to both electric and process steam departments.

A basis of reasoning commonly applied is to consider either electric generation as a "byproduct" of process steam production or vice versa, depending upon which is thought to be the most important. For example, the primary purpose of a plant may be to generate electrical energy. However, if it is possible to sell process steam to near-by customers this may be done at an attractive rate, since there are very appreciable over-all economies in bleeding off this steam after it has passed part way through the turbines. The reasons for this are well known to any steam plant engineer.

In such a case, since electrical energy has to be generated as a main requirement, the process steam load

is often considered a "byproduct" and the fuel cost to produce this steam is taken to be merely the additional cost over straight condensing operation of the electric plant. In other words, the fuel required for generating a certain electrical load with no process steam extraction may be known from experience or it may be calculated. With extraction the fuel consumption of the plant will be increased somewhat, but due to the economies involved the increase will not be in direct relation to the British thermal units supplied to the process steam sent out.

If only the cost of this additional plant fuel is charged to process steam production, it is easily seen that on this basis the cost for fuel per thousand pounds of process steam will be a relatively low figure, since the entire economy or total saving resulting from the combined operation of both electric and steam departments has reverted wholly to the process steam department. Electrical generation receives no benefit with respect to its fuel cost, the cost being the same as if it were operated solely as an independent electric plant.

Likewise, if a plant is interested primarily in the production of steam for process or heating purposes and if the steam is first passed through turbines, the electrical energy generated as a result is often considered as "byproduct," and if only the additional fuel cost is considered as being chargeable to electric generation, then the calculated fuel cost for electrical energy will be low, since this department has received the entire benefit of the combined operation of both departments. The process steam division receives no benefit in fuel cost, its cost remaining the same as if the steam were produced in an independent or isolated steam-generating plant.

Any method of apportionment based on reasoning similar to the above two examples will be termed herein as a "byproduct" basis. In analyzing this method it does not seem logical that the mere viewpoint of which is the principal department of a plant (which in some cases would be very difficult to decide) should have such a tremendous effect on the apportionment of the plant fuel cost. In fact, there is no valid reason why this consideration should enter into the problem at all.

The actual facts involved in the problem are that the total fuel cost for producing a certain amount of electrical energy plus a certain amount of process steam is less in the turbine extraction or combined plant than if each division had its own separate plant. An over-all or total economy is the result. Therefore, to be fair, each department should share this over-all economy, since the existence and simultaneous operation of *both* departments is essential in obtaining it. The "byproduct" basis does not do this, since one department is favored to the extent that the fuel cost of the other remains fixed at or near a value which represents its operation as an isolated plant.

Perhaps the most common method of fuel apportionment is the British thermal unit basis. With the regard for the importance of heat-balance calculations, it can be shown that a fuel apportionment based purely on British thermal units chargeable to the respective departments and calculated back through boiler efficiency to fuel, will be fundamentally unfair. One of the principal reasons for this is that the actual heat drop through a turbine is relatively small, and therefore the fuel apportioned to electrical generation is likely to be a small percentage of the total plant fuel. On a straight condensing or independent plant basis electrical generation involves large heat losses in the condensers. Extracting steam from the turbines, although requiring somewhat more throttle steam to produce the same electrical load, effects an over-all economy by reducing the pounds of steam passing to the condenser, and consequently there is less heat lost to the circulating water.

On a straight British thermal unit basis of apportionment, therefore, electrical generation as an individual department gets an unearned benefit, since it is relieved of a portion of these losses which would be unavoidable were it not for process steam extraction. The usual result of a heat balance British thermal unit basis will be found to be that the process steam department will have to bear a fuel cost which will be substantially the same as if the steam were supplied from an independent steam-generating plant. The method is therefore unfair to process steam production, since electrical generation apparently receives more than its share of the benefit resulting from the combined production of both commodities in the one turbine extraction plant.

As stated previously, there is no rigidly correct basis for apportioning plant fuel costs in the combined plant. The objection to all of the methods so far described has been that either the electrical or the process steam division is unable to show a lower fuel cost than if it were operating alone or as an isolated plant. Similarly, by these methods, the other department will enjoy a fuel cost much lower than it could possibly expect when operating alone or as an isolated plant.

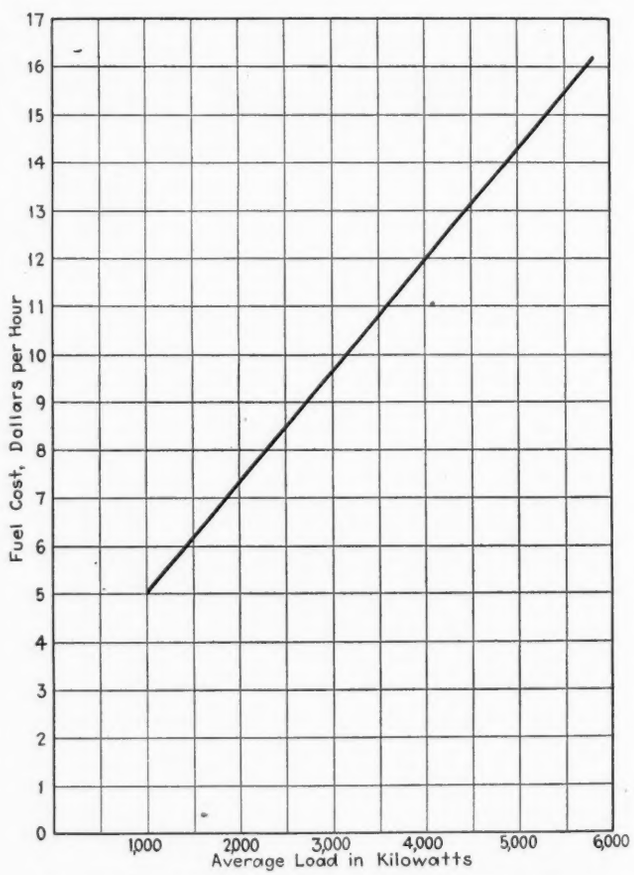

Fig. 1—Fuel cost to operate plant for electrical generation only. (No process steam extraction.) Basis $3.50 coal, 10,500 B.t.u. per pound

It would seem, therefore, that any method devised to give a fair apportionment should allow each department to share in the over-all plant economy and thereby obtain

fuel costs which will be less in each case than possible with independent plant operation. The over-all economy involved, once it has been determined, can be divided equally or on the basis of any desired proportion. An equal split of the saving, however, would appear to be the most logical, since basically both departments are of equal importance in obtaining it.

Assume, for example, the problem of a high-pressure steam plant with condensing equipment and steam for a process load being extracted from the turbines at a nominal pressure. The first step will be to determine

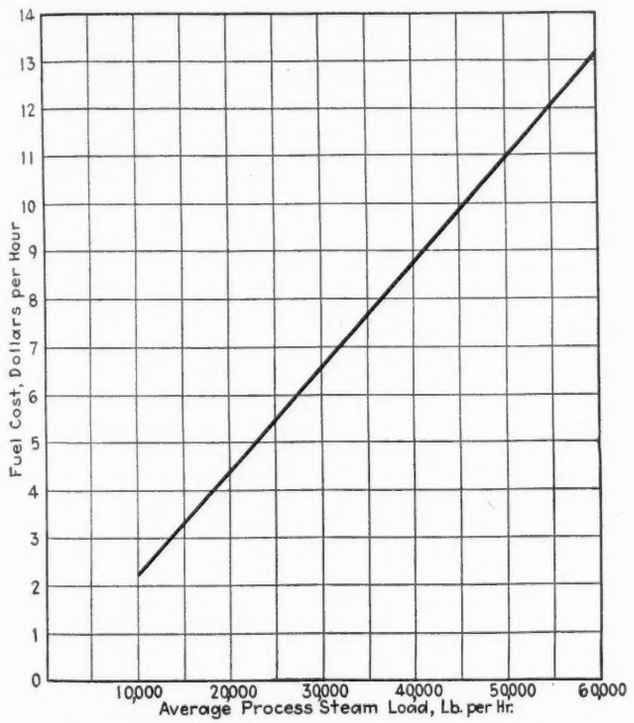

Fig. 2—Fuel cost to supply process steam load from independent plant. Basis $3.50 coal, 10,500 B.t.u. per lb.

the fuel costs separately for the two departments as independent plants.

In the case of electrical generation, the fuel costs should be determined for a straight condensing plant, the only extraction being for feed-water heating purposes. Unless there are unusually complicated local conditions, it is best to base the calculations on the performance of the actual existing plant for average operating conditions but without the extraction to heat department. Possibly some corrections for condenser vacuum, etc., may have to be made due to the absence of process steam extraction.

The manufacturer's guarantees and data for the turbines, boilers and other equipment may be resorted to if actual plant data for the conditions set up (no process steam extraction) is not available. Fuel costs should be worked out for the different electrical loads, both above and below the usual average conditions. Costs should be in dollars per hour for the various loads in kilowatts. This has been worked out for the plant under consideration as shown in Fig. 1.

Fuel costs should also be worked out for the process steam department as an isolated plant. A theoretical set-up may be made on the basis of modern low-pressure boilers with heat recovery apparatus if the price of coal or other fuel used will justify the consideration of this equipment. Otherwise, if the actual plant happens to have boiler equipment suitable for low-pressure operation, the fuel calculations may be based on estimated efficiencies and performance of this equipment. In any event, the most economical operation practicable should eventually be chosen as representing the fuel costs of the process steam department when functioning alone. Fuel costs should be worked out for a rather wide range of steam outputs, so that values above and below actual average conditions will be known. Costs should be in dollars per hour for the various steam loads in thousands of pounds. This is shown graphically in Fig. 2.

If the foregoing steps have been completed, it will be possible to determine the probable cost in dollars per hour for supplying any given kilowatt electrical load. Likewise, the cost in dollars per hour will have been determined for any given process steam flow. These figures, of course, represent operation on the basis of independent plants for each of the two departments. It is desirable to plot curves so that the data may be shown graphically.

Now the actual operation of the turbine extraction plant is usually known day by day from the plant records. Let us assume a typical day for the plant, and the following data and calculations will indicate the procedure in apportioning the fuel.

ACTUAL COMBINED PLANT OPERATION
(From Plant Records)

Total kw.-hr. generated for the day	96,000
Average hourly kw.-hr.	4,000
Total process steam supplied for the day, lb.	480,000
Average hourly process steam load, lb.	20,000
Total coal burned for the day, tons	96.0
Average amount coal burned per hour, tons	4.0
Average cost of fuel per hour @ $3.50 per ton	$14.00

HYPOTHETICAL OPERATION
(As obtained from Figs. 1 and 2)

	Per Hour
Average cost to generate 4,000 kw.-hr.	$12.00
Average cost to supply 20,000 lb. per hr. process steam	4.40
Total cost this basis	$16.40

FUEL AND FUEL COST APPORTIONMENT

	Per Hour
Hypothetical cost	$16.40
Actual cost	14.00
Saving due to combined operation	$2.40
Total saving divided equally between both departments (for each)	$1.20
Fuel cost, electric generation, apportioned, $12 — $1.20 =	$10.80
Fuel cost, process steam production, apportioned, $4.40 — $1.20 =	$3.20
Total (to check with actual cost)	$14.00
Per cent fuel chargeable to electric generation	77.15
Per cent fuel chargeable to process steam	22.85
Total	100.00

The above apportionment allows each department to share in the over-all economy of the combined plant. The fuel cost for process steam from the above calulation is $0.16 per thousand pounds.

With reference to the results that would be obtained by other methods, a "straight British thermal unit apportionment" would have given a cost of approximately $0.22 per thousand pounds. On a "byproduct" or "excess-cost-over-straight-condensing-operation" basis, the cost would have been $0.10 per thousand pounds.

It is obvious that the accuracy of the recommended method is dependent upon the correctness of the hypothetical assumptions and calculations which must be made. It is felt, however, that the method is fundamentally fair, which statement cannot apply to the other methods if an impartial attitude toward the problem is taken.

There naturally are a number of variations in actual procedure in applying the recommended method. For example, the hypothetical data or curves do not necessarily have to be on an hourly basis. However, for

important work, such as rate-making, it is desirable to make calculations which follow the form of the plant load curves. In this way the effect of hourly variations in the loads for the departments will be taken into account more accurately. In general, however, the procedure in apportioning fuel as recommended herein should be worked out to give a degree of accuracy commensurate with the importance of the particular problem.

If the procedure as described is felt to be too cumbersome for daily or routine application, short cuts may possibly be worked out or arbitrary methods devised that will give approximately the same results as the complete analysis recommended. For example, in one plant it was found that by charging the fuel for process steam on the basis of 100 per cent boiler efficiency applied to the British thermal unit actually contained in the process steam extracted, the fuel apportionments would check closely with the results of the method recommended. This shorter method, which happened to give the desired result for this particular plant, has the effect of charging the electric generation with enough additional British thermal units in the form of plant and boiler losses to overcome the defect of the heat-balance British thermal unit method.

Before depending on any shorter method, however, it should be carefully compared with results obtained by the complete recommended procedure to see that the proper relations hold throughout all combinations of loads and conditions of electrical generation and process steam production likely to occur.

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Life and Characteristics of Orsat Reagents Compared

HEAT-BALANCE determinations made from boiler test data can only be as accurate as the Orsat gas analyses from which the calculations are made. The reliability of results obtained with the Orsat depend not only upon the operator, method and frequency of sampling but also upon the solutions used and the operator's knowledge of their characteristics and efficiency.

Time is a most important factor in all Orsat work, since the largest items of expenses in flue gas analysis is labor. Hence any improvement in solutions or apparatus that will reduce the time required in making the analysis will result in important savings.

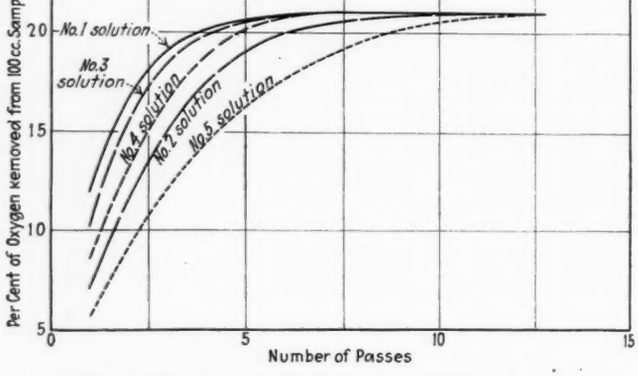


Fig. 1—Relative speed of oxygen absorption with various reagents

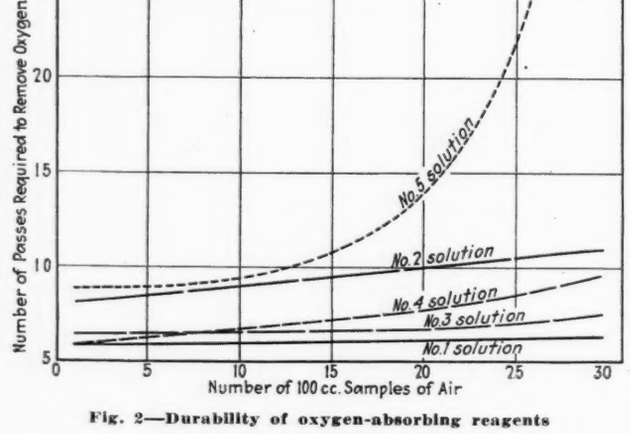

Number of Passes Required to Remove Oxygen
No. 5 solution
No. 2 solution
No. 4 solution
No. 3 solution
No. 1 solution
Number of 100 cc. Samples of Air

Fig. 2—Durability of oxygen-absorbing reagents

With this object in view tests were made comparing the minimum time required, number of passes for complete absorption and life of a number of solutions for absorbing oxygen and carbon dioxide; also the absorbing speeds of a solution in two types of pipettes were studied.

Five different oxygen-absorbing solutions were tested. One solution was put into each of the five capillary type pipettes of a five-point Orsat and tested simultaneously. A total of thirty 100-c.c. samples of air were analyzed to determine the rapidity of absorption and the durability of the solutions. Readings were taken after each pass during the analysis of the first ten samples and at less frequent intervals on the remainder of the samples. The Orsat was checked at frequent intervals for leaks, and at no time did the leakage exceed 0.4 c.c. in five minutes.

The chemical compositions of the oxygen solutions used, reduced to a 1,000-gram basis, are as follows:

Alkaline Pyrogallic Acid Solution	K O H Grams	Pyrogallic Acid Grams	Water Grams
No. 1	142	168	690
No. 2	347	36	617
No. 3	227	91	682
No. 4	586	24	390
No. 5	Proprietary solution, probably chromous chloride		

Solution No. 1 is prepared in the following manner:

1. Using a pyrex beaker dissolve 34 grams of C. P. potassium hydroxide (not purified in alcohol) in 85 grams of distilled water. Allow this solution to cool.

2. Dissolve 40 grams of resublimed pyrogallic acid in 80 grams of warm distilled water.

3. Mix the cooled potassium hydroxide solution with the pyrogallic acid solution and pour into the oxygen absorption pipette. Take necessary precautions at all times to minimize contact of air with the pyrogallic acid solution.

These quantities specified will make sufficient alkaline pyrogallic acid to approximately fill a 200-c.c. Orsat pipette to the proper point (one-half full).

Criticism has sometimes been made of highly con-

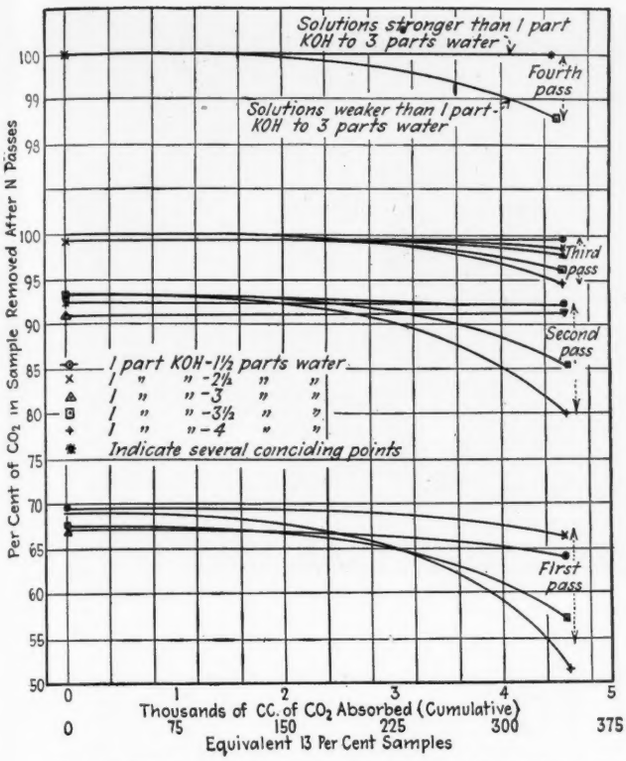

Solutions stronger than 1 part KOH to 3 parts water
Fourth pass
Solutions weaker than 1 part KOH to 3 parts water
Third pass
Second pass
1 part KOH-1½ parts water
1 " " -2½ " "
1 " " -3 " "
1 " " -3½ " "
1 " " -4 " "
Indicate several coinciding points
First pass
Per Cent of CO2 in Sample Removed After N Passes
Thousands of CC. of CO2 Absorbed (Cumulative)
Equivalent 13 Per Cent Samples

Fig. 3—Relative speed of CO_2 absorbtion with various strength potassium hydroxide solutions

centrated pyrogallic solutions on the ground that carbon monoxide may be formed. The No. 1 solution of this study was checked for evolution of carbon monoxide as was a solution 50 per cent more concentrated. Neither evolved carbon monoxide.

Too highly concentrated solutions of alkaline pyrogallic acid are, however, to be avoided for another reason. As the concentration increases beyond the value of the number one solution, the viscosity increases quite rapidly and the time required for passing the gas into and out of the absorbing pipette more than offsets any advantage in greater absorbing capacity. The number of passes required for complete absorption is increased with the increased viscosity of highly concentrated solutions.

The curves of Fig. 1 show the relative speeds at which the various solutions absorbed oxygen and the number of passes necessary for complete removal of the oxygen in the 100-c.c. sample of air analyzed.

Solution No. 1 consistently removed from the samples of air more oxygen on each pass than any of the other solutions. It also removed all of the oxygen with fewer passes than any of the other solutions except solution No. 2, which in this respect gave equally good results. Solution No. 5 removed less oxygen on each pass and required more passes to remove all of the oxygen than any of the other solutions.

From Fig. 2 the durability of the oxygen absorbing reagents may be obtained. The curves show how the number of passes required to remove all of the oxygen increases with use of the solutions. Solution No. 1 again appears best, as it continued to remove all of the oxygen from the samples of air with the least number of passes. The proprietary reagent solution No. 5 became saturated with oxygen after 26 samples.

A comparison of the absorption and life of five different strength solutions for absorbing CO_2 is shown by the curves of Fig. 3. The solutions were used in the capillary pipettes of a five-point Orsat. The first 50 analyses made were of flue gas. To accelerate the determination of the life of the solutions samples of 30 to 90 per cent pure CO_2 were analyzed. The reagents compared are all solutions of potassium hydroxide of the following strengths:

Solution	Parts Potassium Hydroxide	Parts Water
1	1	1½
2	1	2½
3	1	3
4	1	3½
5	1	4

The amount of CO_2 gas that can be absorbed by the various solutions appears to be in excess of the limits usually set. A total of 4,600 c.c. of CO_2 (375 flue gas samples of 13 per cent CO_2) can be absorbed without appreciable effect on the absorbing qualities of any but the two weakest solutions. Only five passes are required to absorb all of the CO_2 from a flue gas sample containing 13 per cent after a total absorption of 4,600 c.c. of the gas.

Capillary and Bubbling Pipettes

Fig. 4 shows a comparison of the number of passes and time required completely to absorb CO_2 from a sample of flue gas when using solutions of the same strength in pipettes of the bubbling and capillary types. The number of passes required to remove all of the carbon dioxide was two for the bubbling pipette and three for the capillary pipette when the flue gas samples contained 12 per cent CO_2. The time required for the analysis was three times greater with the bubbling pipette than with the capillary pipette. This is because it took about 50 sec. per pass with the bubbling pipette as compared with 10 sec. per pass with the capillary pipette.

It should be observed that the results of these tests are not to be regarded as a final answer to the problem, but rather they should serve to guide further investigations and to give useful information to those who may choose to use solutions of the strength tested.

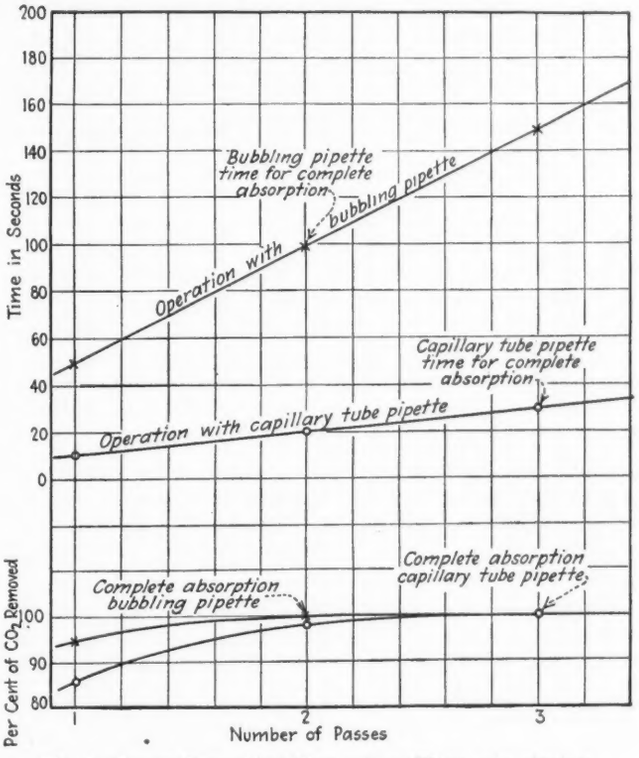

Bubbling pipette time for complete absorption
Operation with bubbling pipette
Capillary tube pipette time for complete absorption
Operation with capillary tube pipette
Time in Seconds
Complete absorption bubbling pipette
Complete absorption capillary tube pipette
Per Cent of CO2 Removed
Number of Passes

Fig. 4—Comparison of bubbling and capillary tube pipettes

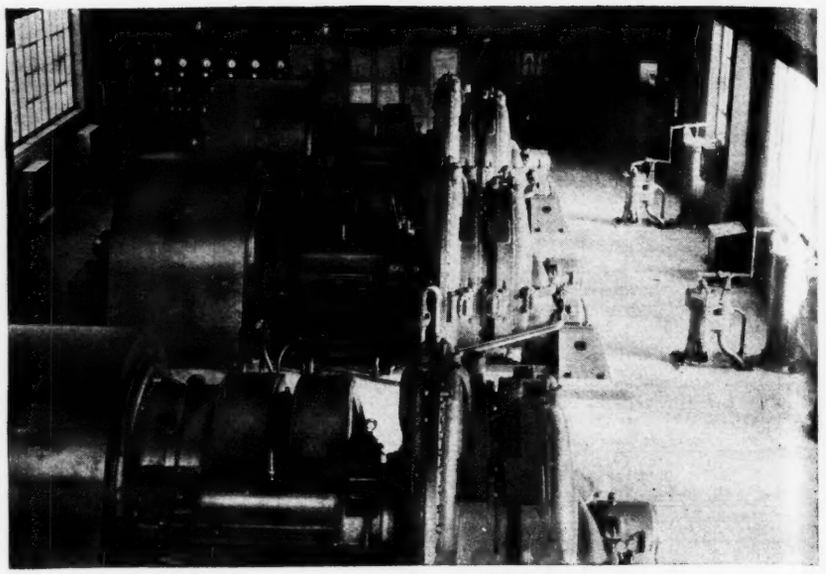


Fig. 1 — Three Blowers each delivers 31,700 cu.ft. of air per minute at 26.8 lb. per square inch; driven by 3,600-hp. 750-r.p.m. induction motors through gears to obtain 5,380 r.p.m. blower speed

By E. C. DIEFFENBACH
Industrial Engineering Dept.
General Electric Company

Motors and Control for Fans, Blowers and Exhausters

A summary of motors and control available, subdivided into power, alternating-current and direct-current; speeds, constant or variable; and torque requirements helpful in a study of electric drives for fans or blowers. Definite applications in successful operation illustrate what has been accomplished

MOTOR, fan and blower manufacturers have cooperated in many ways to obtain the most efficient and satisfactory combination of motor and driven equipment. The fan and blower manufacturers know the characteristics of their machines by consulting curves obtained by plotting values such as volume of air, horsepower input, pressures, etc.; the motor manufacturers have at their disposal all the important motor characteristics. By judicious comparison a complete unit which will operate successfully over the operating range can be selected. Motor and fan characteristics are then such that underload and overload do not exceed the allowable limits.

In general, the following laws apply for fans and centrifugal compressors: discharge pressure varies as the square of the speed; rated volume varies directly as the speed; and power required varies as the cube of the speed. If the volume is maintained constant the power varies as the square of the speed. If the speed remains constant the power varies directly with the volume.

An examination of these laws shows that for variable-speed operation the power input varies between wide limits, increasing rapidly as the speed goes up. They also show that for constant-speed operation the power increases with a rise in volume and pressure. This limits the discussion to constant- or variable-speed operation and motor and control selection.

On a constant- or a nonconstant-speed application the user is governed first of all, by the power supply. If direct current is available a choice can be made of series-, shunt- or compound-wound motors, to suit the individual fan or blower requirements. When the source of power is alternating current, a selection may be made from such motors as squirrel-cage and wound-rotor induction, the synchronous and the brush-shifting types.

When the power source is direct current the compound-wound motor is satisfactory for constant-speed service, since it has a speed-load characteristic opposite to that of the average centrifugal compressor or fan. The tendency of the motor to overload or underload on

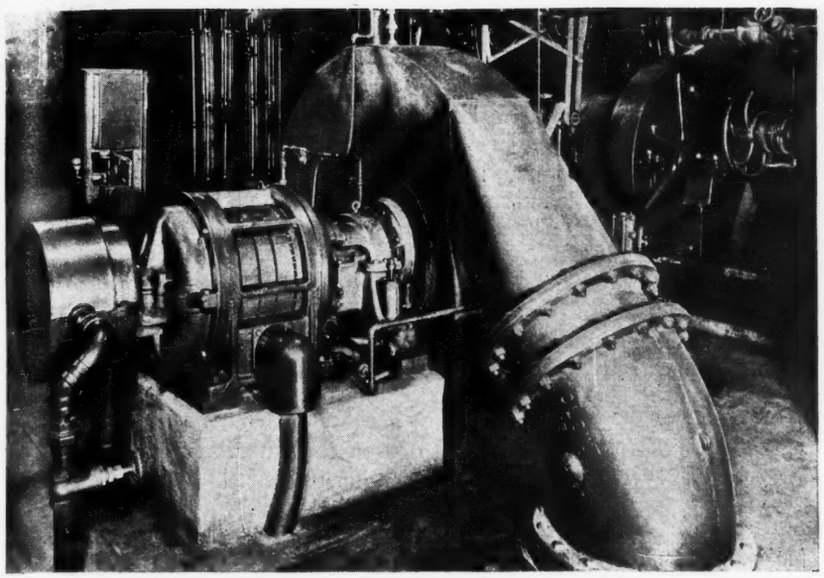


Fig. 2—Exhauster used in the manufacture and distribution of gas, with a capacity of 7,150 cu.ft. per minute at 2.66 lb. per square inch pressure. This compressor is driven by a 75-hp. wound-rotor induction motor through gears to obtain a 5,750-r.p.m. exhauster speed. The motor's slip rings are totally inclosed in a housing and air is supplied from an external source

variation of voltage or air resistance is counteracted and the operation is stable.

Various methods of hand or automatic control are available. For motors under 20 hp., hand starting is feasible by fused line switches and starting rheostats. For the larger ratings automatic magnetic controllers can be had in a variety of types for uniform acceleration of fans or centrifugal compressors. Control from some remote point by push-button or by pressure or temperature device can readily be adapted to fan or compressor service. Undervoltage release for shutting down the motor on voltage failure and restarting upon return of voltage is a regular feature of many automatic control systems.

The direct-current motor is readily adaptable for adjustable-speed operation, since it has inherent ability for fine speed adjustment. Speed change can be secured by field adjustment or by a combination of field and armature control. Where such factors as pressure or volume are variable, this is a desirable feature and permits adjustment of motor speed to secure the correct fan or compressor speed.

If the power source is alternating current the squirrel-cage motor is one of the most popular fan or compressor drives for constant-speed service. Its simplicity and sturdiness recommend it for heavy duty. Squirrel-cage motors are available in several electrical designs, depending on the starting torque desired and on the torque required at full speed. Standard motors usually have sufficient accelerating torque for most applications. The curves (Fig. 3) show power supplied to a centrifugal compressor at various capacities by a constant-speed squirrel-cage induction motor.

Starting switches for throwing motors directly across the line may be used for starting smaller sizes where line disturbances incurred are not objectionable. Magnetic switches with push-button starting are also quite popular. Undervoltage protection or release and overload relays are essential parts of starting equipment.

The low-speed synchronous motor is a satisfactory drive where the speed is constant and the rating is over 40 hp. when provision is made to allow the motor to pull into synchronism. Two methods are commonly used for doing this: A clutch may be used to connect the load after the motor has reached synchronism; or advantage may be taken of the ability of the super-synchronous motor to supply full-load torque when approaching full load. The stator of the super-synchronous motor is free to rotate and comes up to synchronism without load. A brake is then gradually applied, bringing the stator to rest while the rotor with its attached load comes up to speed. At all times, the full pull-out torque is available for bringing the load up to synchronous speed.

The power-factor correcting qualities of the synchronous motor is often of considerable importance where the over-all plant power factor is low. An analysis of plant conditions often points a way to employ the synchronous motor to that end with beneficial results, both from an economic and a plant operating standpoint.

Starters for synchronous motors vary with the degree of manual or automatic operation desired. The reduced-

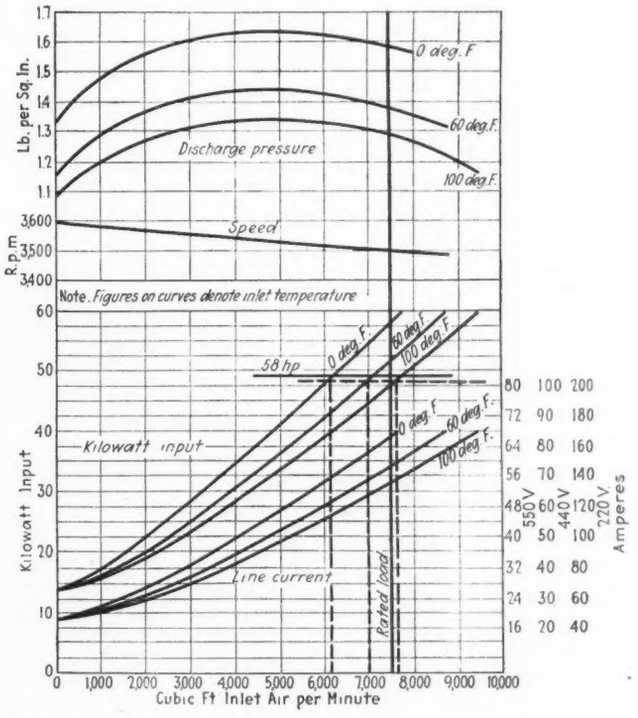


Fig. 3—Curves showing power supplied to a centrifugal compressor by a 58-hp. squirrel-cage motor

voltage starter with automatic application of field current, utilizes the hand-starting compensator and field-actuating contactors which allow the field excitation to be applied upon reaching a speed nearing synchronous. The full-voltage starters with oil switches throw the motors directly on the line and apply the field automatically when the rotor is almost up to speed. Full-automatic starters, both at reduced and full-voltage, perform all starting operations by push button.

Variable-speed operation, when the source of power is alternating current, is usually obtained with wound-rotor induction motors or with brush-shifting motors. The wound-rotor induction motor is most popular when the speed reduction is not too great. When speed reduction is greater than 50 per cent. rheostatic losses are excessive. Speed reduction is commonly obtained by increasing the resistance in the rotor winding; consequently this type of motor is best suited for variable speeds near full speed.

Various degrees of automatic control can be secured by across-the-line starters, magnetic controllers, remote control by push-button station and by other means. Magnetic controllers provide uniform acceleration without excessive current inrush when motors are too large and when it is desirable to keep down line disturbances.

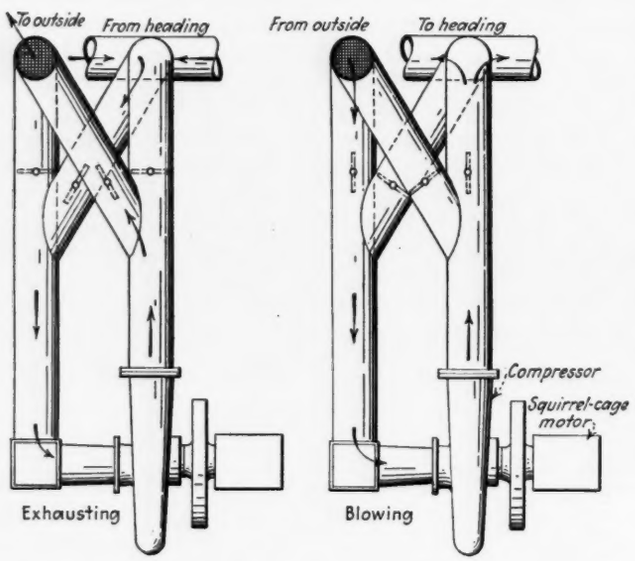


Fig. 4—Arrangement of piping and gates to allow reversing the direction of air flow in the system without reversing the blowers

Brush-shifting motors are admirably adapted to adjustable-speed service where considerable speed reduction is required. Their efficiency is higher at the low speeds than with the wound-rotor induction motor, and speeds higher than synchronous are possible. Creeping speeds can be secured by inserting resistance in the secondary circuit, and an infinite number of speed points permit variable-speed operation in the fullest sense of the word.

Speed change is secured by shifting the brushes manually with a handwheel located directly on the motor frame, or remotely by handwheel and chain. Speed change can also be secured by means of a pilot motor controlled from a remote point.

A brush-shifting motor is started by connecting it to the line as any three-phase induction motor would be, or by a magnetic controller if desired. The popular magnetic controllers provide reduced voltage and overload protection where such features are desirable on account of large size or limited line capacity.

Where electric motors and control are used to drive fans or centrifugal compressors in hazardous locations such as refineries, gas plants or mines it is well to arrange for adequate protection to prevent flashes or sparks originating within the equipment from being transmitted to atmosphere. Totally inclosed fan-cooled motors with a supply of clean air and an outlet to atmosphere are protected to some extent. Inclosure of the collector rings only, in case of synchronous or wound-rotor motors, makes them as safe as ordinary exposed squirrel-cage motors. Fire walls separating the motor from the compressor permit the motor to operate somewhat removed from the danger zone. One of the safest motors for use in a hazardous location is the squirrel-cage explosion-proof type designed in accordance with underwriters' specifications. These motors have inclosing cases of sufficient strength to withstand internal explosions and wide flanges to permit the hot gases to cool before they reach the outside of the inclosure.

Control for motors operated in hazardous locations can be divided into three classifications: (1) hand or automatic control located outside of the hazardous area; (2) control outside of the hazardous area operated from a protected-type push-button station within the danger area; and (3) special control protected according to underwriters' specifications.

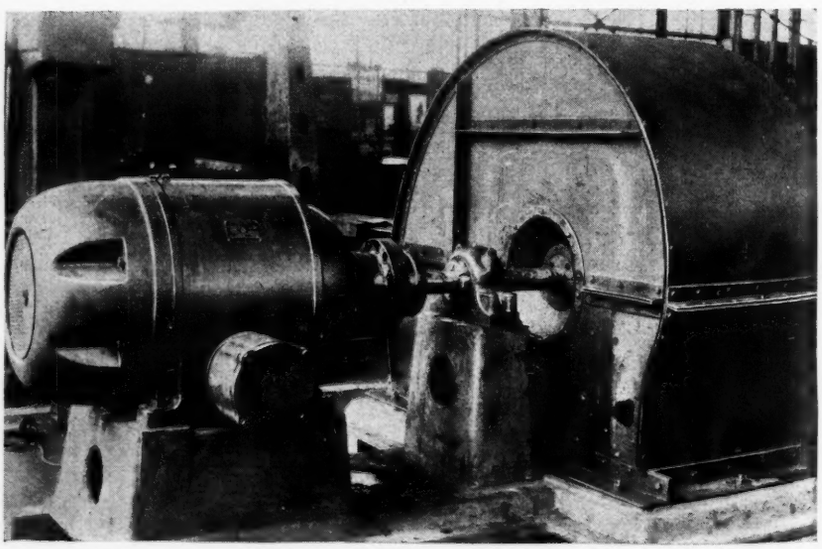


Fig. 5—Totally inclosed, fan-cooled, 60-hp., 1,800-r.p.m. induction motor directly connected to a ventilating fan in a location where explosive gases are present

Control designed to meet underwriters' specifications is usually designed with contacts and other parts inclosed in explosion-proof cases of wide-flange construction, or with contacts immersed in oil of approved depth and other parts in a separate explosion-proof compartment.

TYPICAL APPLICATIONS

Fans or centrifugal compressors are particularly adapted to such industrial applications as agitation, gas manufacture and distribution, combustion, conveying, ventilation, cooling, the manufacture of chemicals and miscellaneous blowing such as glass blowing, nitrogen production, oil engine scavenging, paint atomizing, sand-blasting, oil engine superchanging and vacuum cleaning. Electric drive insures adequate power at finger-tip control and provides means for the regulation so vital in many of these operations.

The ventilation of the New York water tunnel during construction was accomplished with centrifugal blowers rated 7,500 c.f.m. at 2.5 lb. per square inch pressure, direct connected to 120-hp. squirrel-cage motors running at 3,600 r.p.m. Fifteen such sets were used to clear the various working faces of the tunnel of noxious gases and to supply them with fresh air. An ingenious arrangement of gates was utilized to accomplish reversal of flow without reversing the motors, as shown in Fig. 4.

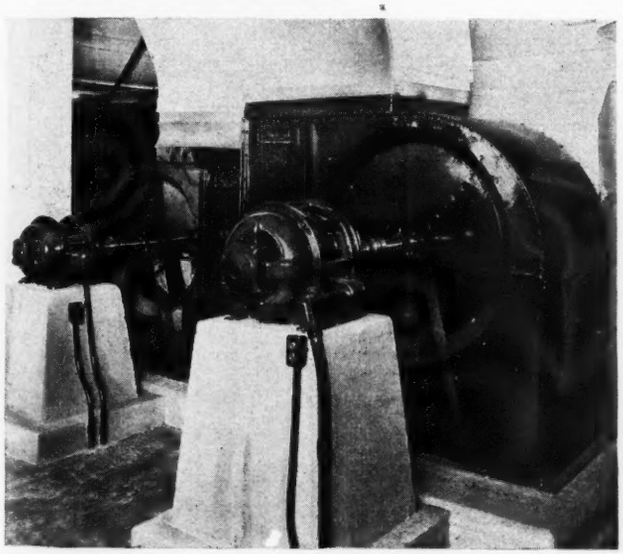
An electrically driven centrifugal compressor with automatic control supplies a constant weight of air to a cupola. The control operates on the assumption that the weight of air supplied is constant when the power input is constant. Since the line voltage is fairly constant, the current input varies as the power input. Suitable contactors close when the ammeter needle deviates from its position and current is supplied to a small reversible motor, opening or closing the blast gate in the cupola line and maintaining a constant flow of air. A constant weight of air can be supplied by the blower from 30 per cent of normal load to 20 per cent overload. A centrifugal compressor having a rating of 4,200 c.f.m. at 1 lb. pressure supplies a constant weight of air to a cupola. The squirrel-cage motor is direct connected and is rated 27 hp. at 3,500 revolutions per minute.

Blowers, Fig. 1, each for supplying 31,700 cu.ft. of air per minute at 26.8 lb. per square inch to Bessemer converters in a steel plant are driven by 3,600-hp., 750-r.p.m., 2,200-volt, 25-cycle wound-rotor induction motors. The speed of 5,380 r.p.m. is obtained through speed-increasing gears. Each unit is one of the largest electrically driven blowers for this kind of service in operation and represents a departure from regular turbine-driven units.

Electrically driven centrifugal air compressors for pneumatic conveying of all kinds have become quite popular in the last few years. The differential-pressure and the velocity system are probably the best known. The differential-pressure system depends upon a difference in pressure between the sending and receiving ends of the container. The difference in pressure is produced either by suction at the receiving end or by pressure at the sending end and is regulated by automatic valves. Such a system has been in operation in the New York Stock Exchange Building for over 10 yr., where dependability and speed are of prime importance. A large traffic in buying and selling orders is quickly dispatched when a rapidly changing market stimulates trading. The compressors are rated 7,500 cu.ft. per minute at 1.5 lb. pressure and 3,450 r.p.m. and are driven by 90-hp., 230-volt direct-current motors. Six duplicate units are used in this system.

The constant-velocity conveying system keeps such materials as ashes, grain, pulverized coal, soda ash, starch and other materials in mechanical suspension so that they cannot stop or lodge until they are discharged. The electrically driven centrifugal compressor inherently maintains constant suction when the materials handled vary in volume, power requirements varying directly with the volume handled. The ash-exhausting compressor in the New York Life Insurance Building supplies 4,000 cu.ft. per minute at 31 lb. per square inch equivalent pressure when operating at 3,500 r.p.m. The motor is a direct-current, 230-volt type rated at 85 horsepower.

Fig. 6—Quiet-operating squirrel-cage induction motors driving fans for air-conditioning in an office building



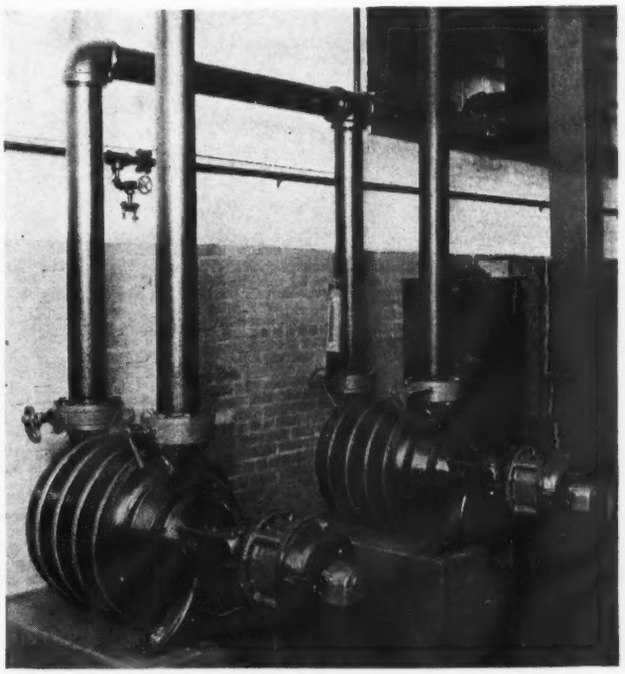


Fig. 7—Two 8-hp. 3,500-r.p.m. squirrel-cage induction motors driving centrifugal compressors supplying air for agitating water in ice manufacturing

Blowers and exhausters used in the manufacture and distribution of gas are readily electrically driven when electric power is available. Constant- or variable-speed operation is accomplished with either direct current or alternating. A typical example of gas-exhausting is found in exhauster, Fig. 2, having a capacity of 7,150 cu.ft. per min. at 2.66 lb. per square inch pressure and operating at 5,750 r.p.m. The exhauster is driven by a 75-hp., 1,800-r.p.m. wound-rotor induction motor through a speed-increasing gear. The slip rings are inclosed in a housing and air is supplied from an external source, providing safety equal to that of open squirrel-cage motors.

Motors totally inclosed, fan-cooled and with wide-flange construction are highly desirable for use as compressor drives in oil refineries, mines and other locations where explosion hazards are encountered. A squirrel-cage motor so inclosed is shown in Fig. 5, direct-connected to a forced-draft fan for use in an oil refinery. The motor is rated 60 hp. at 1,800 r.p.m. and bears the label of the underwriters attesting its suitability for use in such an area.

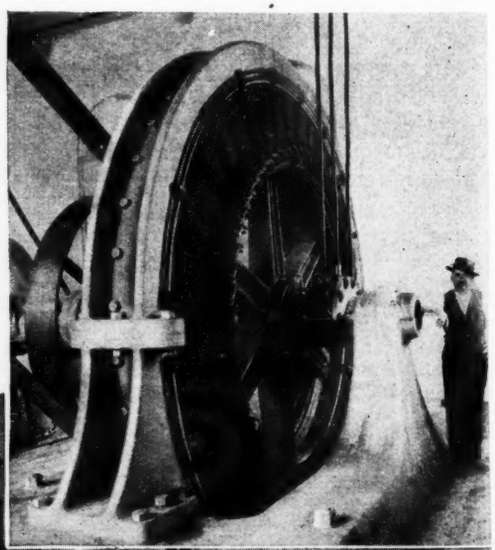
Raw water used in the manufacture of ice requires agitation by clean air. About 3 to 4 cu.ft. per min. at 2.75 to 4 lb. per square inch per ton of ice is required per day. In one plant two small multi-stage compressors, Fig. 7, supply 500 cu.ft. per min. of air each, free of entrained oil vapor, at 2 lb. per square inch. They are driven by 8-hp., 220-volt squirrel-cage induction motors at 3,500 revolutions per minute.

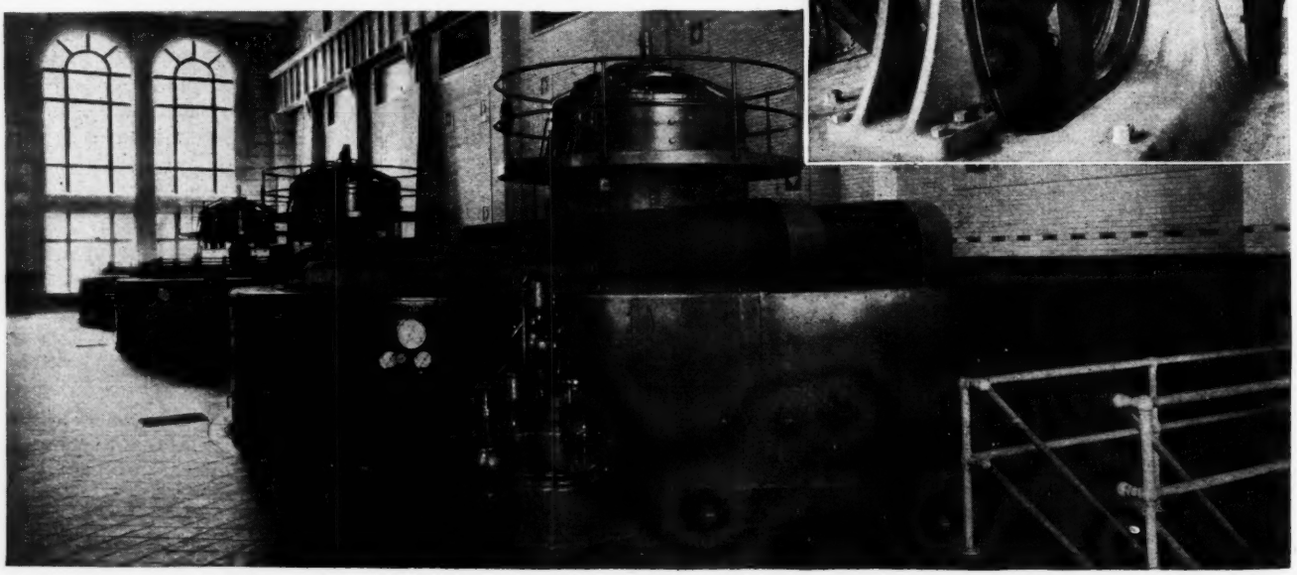
Many of our modern buildings are equipped with full fan and blower complements which have a large part in the manufacture of climate. A supply of clean filtered air with the correct humidity and temperature is supplied summer or winter. The agreeable atmosphere in office buildings, theaters, hotels or trains is especially noticeable where the air is so treated. A direct result is more pleasant working conditions with obvious improvement in the efficiency of the employed personnel or general well being of the patrons.

Steam Explodes Ore

HIGH-PRESSURE STEAM has been and is gradually extending its field of usefulness beyond that of power generation. Before modern power plants were ever head of, farmers popped corn on winter evenings by a process akin to that of a boiler explosion. Corn of popping grade has a thin, tight shell corresponding to a boiler shell. The material within contains moisture. On heating, the pressure goes up to the bursting strength of the shell, whereupon the whole kernel explodes. Sudden release of pressure causes sudden flashing and expansion of the water into steam throughout the mass of the corn, producing the fluffy white mass of the popped corn. A similar process can be applied to substances not naturally provided with a tight shell if this shell is replaced by a container from which the pressure can be suddenly released. By this method various precooked expanded-kernel dry breakfast cereals are produced and wood is expanded into a spongy fibrous mass which is used in the manufacture of building boards.

Recently the Bureau of Mines developed a process whereby steam pressures, suddenly released, are used to pulverize ores. The crushed ore is saturated with water and then heated in a closed container. After a high pressure has been built up the pressure is suddenly released. Rapid flashing and expansion of the steam reduces the ore to a fine powder.





THIRTY-NINE YEARS MAKES A DIFFERENCE — In 1893 the installation shown in the picture on the right was considered quite the last word in hydro equipment. Compare it with the battery of modern, sleek, powerful machines shown below. Photographs courtesy of General Electric Company.

Automatic Safety Devices Protect Internal-Combustion Engines

By WILLIAM M. KAUFFMAN

When emergency stops are made an integral part of internal-combustion engines designed for automatic operation, the engine builder assumes greater responsibility for the unit's safe operation. The methods employed and features of successful design are discussed here

THE TREND in internal-combustion engine power plants toward automatic control of the prime mover, and resulting decrease of power plant personnel, brings up for consideration the protection of the operating unit from breakdown or possible wreckage due to failure of the water system, lubricating system or governor control.

Considering, first, the unusual conditions that would cause trouble, perhaps the lubricating oil system is the largest offender. Failure to open the lubricating oil supply valve to the engine when starting, breakage of chain or gears in the lubricating oil-pump drive, loose connections in the high-pressure line, or allowing the lubricating-oil-storage tank to run low are possibilities which involve the human and also the mechanical element.

The cooling-water system is a vital point in the engine's care and successful operation. Where water is furnished from an overhead tank, a practically constant head forcing the water through the engine is desirable. Where water is pumped from a hotwell or source below the engine level the reliability of the pump is generally assumed to be unquestionable. However, air- or vapor-bound water-cooling systems should be guarded against. In other installations pumps of too small capacity will dangerously increase the outlet temperature of the cooling water. Where globe valves are used to throttle the water outlet from the engine cylinder heads the tendency of the throttle opening to change position due to vibration of the valve has been experienced. Aside from difficulties in the water system, high temperatures indicate excessive overloading due to unbalanced distribution of power in the individual cylinders, piston scoring or faulty timing.

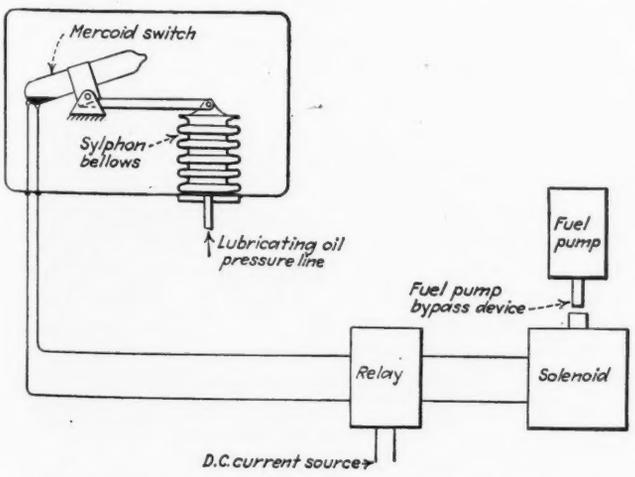


Fig. 2—Operating electrically, this lubricating oil stop acts on the fuel-pump bypass

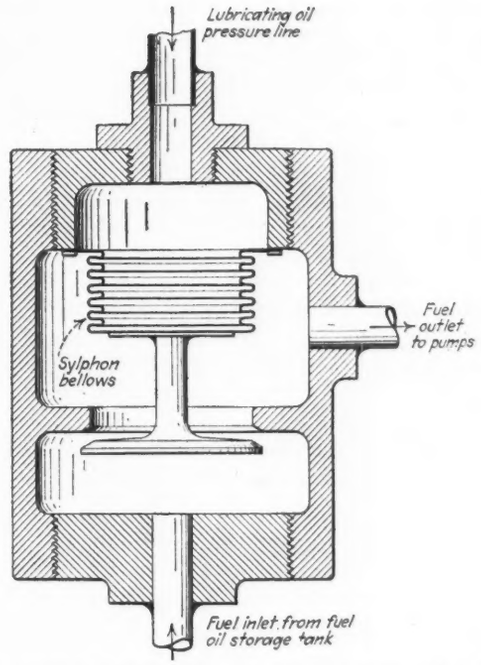


Fig. 1—If the lubricating oil pressure fails, this valve, placed in the fuel oil line to the engine, closes and stops the flow of fuel

The governor control is designed to regulate the engine speed. This sensitive mechanism is not, however, entirely free from mechanical troubles. Instances of broken drive gears are uncommon, but have been sources of much repair when experienced. Likewise, seizing of bushings and breakage of governor springs, all tend to adjust the speed of the engine to the load improperly, or result in excessive speeding up and possible breakdown. Remote cases of oil vapor entering the air intake to cause overspeed are known.

In presenting the above possibilities, it is not the intent to adopt a pessimistic attitude toward the trials of the power plant engineer, but to offer a guide for those that do occur, and so justify the application of emergency stop equipment.

Lubricating Oil Stop

Fig. 1 shows a lubricating oil stop used by a prominent manufacturer. It consists simply of a monel metal sylphon bellows acting directly on the stem of a fuel valve,

which is inserted in the main fuel supply pipe to the engine. When the lubricating oil pressure drops to 10 lb. per square inch the valve automatically closes and shuts the fuel line. It is important that this valve be placed close to the pumps so as to act promptly upon the supply system. Fig. 2 shows an electrically controlled stop. Here the sylphon bellows acts upon a Mercoid switch which in turn energizes a solenoid. The solenoid core acts directly on the bypass of the engine fuel pumps, placing them at stop position, and simultaneously disengages the pump control from the governor control. This construction allows the incorporation of a cooling water-stop in this device, by adding that control to the circuit. The sylphon bellows control is an integral part of the lubricating oil stop and is considered reliable due to the absence of moving parts. When starting an engine, the oil pressure must necessarily be pumped up by hand to open the fuel valve, which is a further precaution toward safety.

The cooling-water stop is as yet none too highly exploited. Most engineers prefer to gage the danger by water pressure, rather than by water temperature, since the condition of high temperature is to be avoided and is

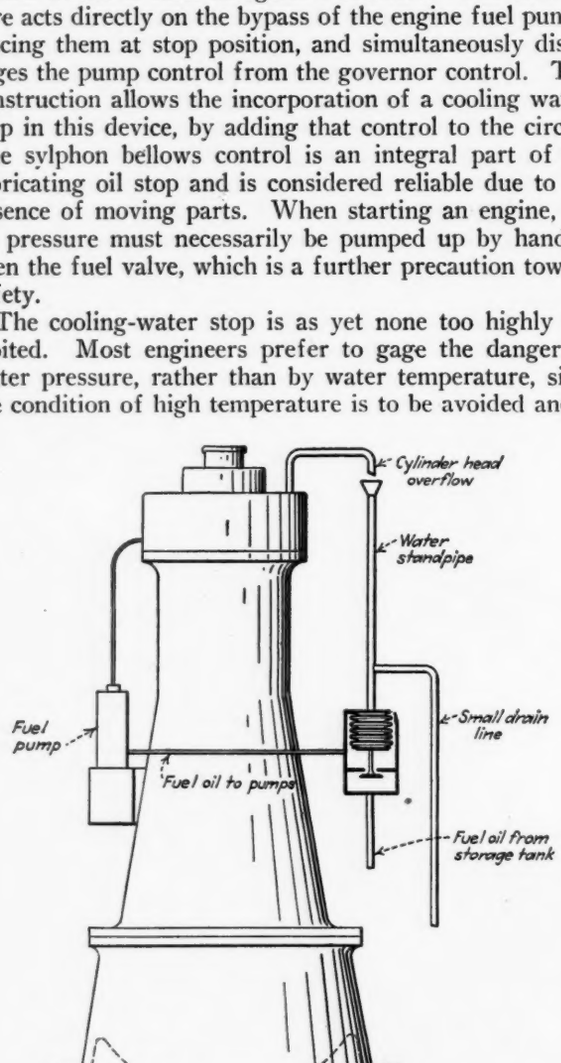


Fig. 3—A cooling-water stop in which the cooling-water pressure operates a valve in the fuel oil line similar to that shown in Fig. 1

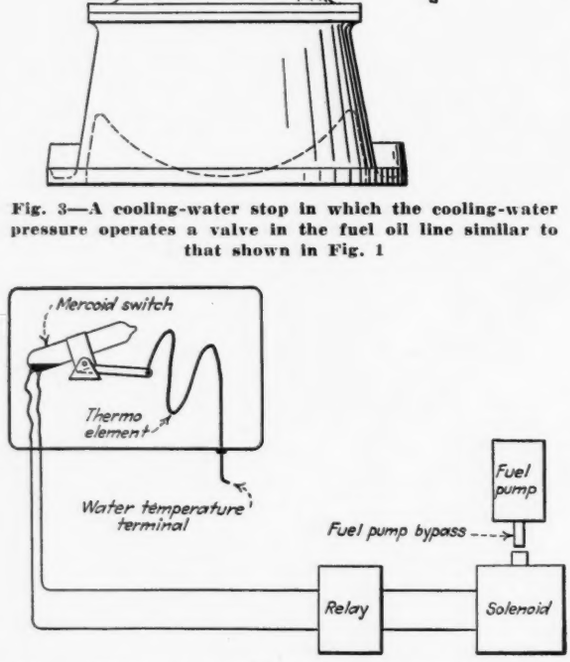


Fig. 4—Diagram of a cooling-water stop operated by the cooling-water temperature

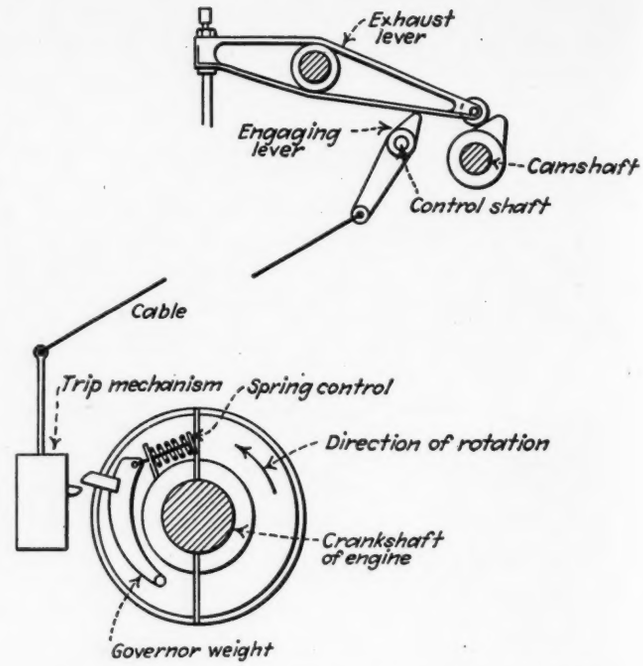


Fig. 5—Overspeed trip device which holds the exhaust valves open

subsequent to failure or drop in water pressure. However, the pressure head difference between the upper water outlet at the cylinder head and the source of water is generally small and does not lend itself to a device that will be entirely foolproof. In the larger engines this difference may be enough to function satisfactorily. Fig. 3 shows such an arrangement. A small standpipe extending the height of the engine receives a constant supply of water from the cylinder-head overflow, thus maintaining a pressure head on the sylphon bellows fuel control valve as described in Fig. 1. A small drain at the bottom bleeds the water off, so that if the water fails the standpipe is drained, reducing the head and closing the fuel valve. Fig. 4 is a diagram of a water temperature control valve. Here the mercoid switch operates a solenoid and its action is similar to the lubricating oil stop. It operates when the temperature of the water rises above normal. The use of a pressure regulator valve is employed where an emergency source of water at sufficient pressure suitable for the engine system is available, such as from an overhead tank or city water supply. The regulator diaphragm valve is teed into the main supply pipe, and when pressure in the main line is reduced, due to pump failure, the valve automatically opens and retains this position until the pressure differential is decreased. An alarm is usually connected to the main water supply line, and will sound simultaneously with the pressure drop.

Emergency overspeed stops function to throttle the engine to a full stop in a few revolutions, as the built up inertia forces due to excessive speed, which increase with the square of the revolutions per minute, subject not only the rotating masses of the engine, but also the flywheel, to possibility of rupture. The most effective means for securing a rapid stop are throttling the air intake or holding the exhaust valves open. In either case, compression of the succeeding charge is disturbed, and combustion destroyed. To detect engine overspeed, a sensitive governor is connected to either the crankshaft or camshaft directly, or driven by chain or gears. The

movement of the governor sleeve or weights causes a trip latch to release the throttling mechanism. Fig. 5 shows a speed limit control in which, as the speed increases, the trigger on the governor weight protrudes from the periphery of the band and trips a latch in the operating mechanism. This in turn releases small levers that due to a spring device on the control shaft, adjust themselves under the exhaust levers.

Another arrangement operates directly upon the air intake by closing a butterfly valve that is built into the intake header. In all these controls the effect is almost instantaneous, and breakdown is quickly avoided.

The tendency toward incorporating such devices into the engine proper is becoming more apparent. Further ingenuity along this line will certainly make the isolated automatic internal-combustion power plant a more feasible proposition and a safe investment.

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Most Economical Number of Compressors for Air Supply

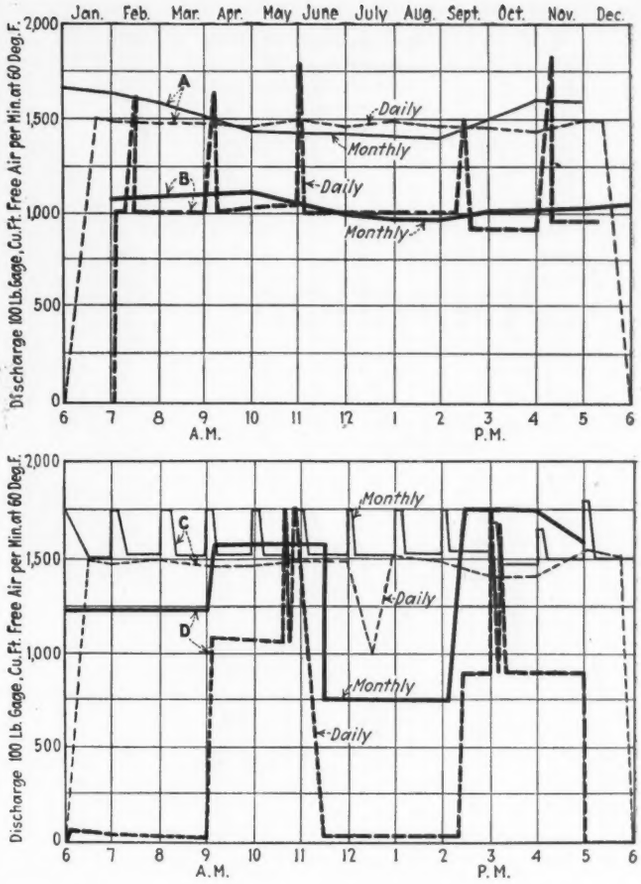
By H. M. SPRING

THE PROBLEM often arises of just how many compressors will suffice with the greatest economy in a compressed-air system. The solution to this question must be considered for each particular case, whether in an industrial plant or for a large generating station.

The first step in determining the best arrangement is to draw two curves, one for the total air requirements hourly on the average operating day, the other to show any seasonal fluctuations for the average operating year. Four sets of typical test curves are shown, each from different types of service.

Referring to curve *A*, it will be noticed that the demand is fairly steady throughout the day and is also about the same throughout the year. Curve *C* shows steady through the day, but due to one particular manufacturing system the demand nearly doubles for several days the first of each month. In both cases compressors of equal rating should be installed, either one being able to carry the greatest demand alone. The only exception to this statement is regarding curve *C*. If the process demand for air can be postponed for several days or a week duplicate compressors may be installed each having been rated without regard to this monthly peak. With such an arrangement if one compressor is down for repairs the other will easily handle the job, while when both are available they may be operated alternately, weekly or monthly. In the first two cases a comparatively small air receiver or resevoir is needed, so long as it is of sufficient size to prevent transmission of pulsations through the piping.

In curve *B* a process demand causes sudden peaks of short duration. It is obvious that to install an additional compressor would be poor policy and to rate each one high enough to carry these peaks would mean running a compressor partly loaded the major part of the time. The proper procedure is to install a larger air receiver than would be necessary for either of the demands indicated by curves *A* and *C*. This acts as a power reservoir, storing up on light demand and supplying



Daily and monthly curves showing compressed air demands

sudden peaks with greater flow than the compressor rating, with minimum pressure drop.

Curve *D* shows a case which calls for three compressors. During the steady flows of several hours duration each day it is a similar case to *A*, but the rest of the curve will show that it involves a combination of the first three cases. The peaks, that result from air soot blowers or a process, call for a large receiver. If compressors are installed in duplicate and each is rated at slightly below the peak value a distinct loss will result during the low demand which exists over 50 per cent of the remaining time. This condition may be improved by the use of a third compressor. This is to be of the "gasoline station" type, a small, high-speed, automatic compressor rated just over the average demand on the low parts of the curve (in the case shown it is less than 10 per cent the size of the larger machines). The pressure switch on the automatic compressor is set to open at several pounds lower pressure than the larger machines operate at when unloaded. By this arrangement when a larger compressor is started the smaller one will stop with no further attention.

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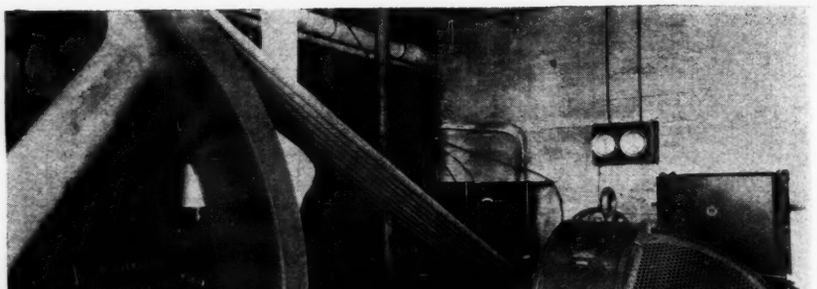
Oil Cooling of Pistons Not Being Discarded—An erroneous statement appeared in *Power*, at the top of page 22 of the Annual Review Number, January 5, 1932, as follows: "Oil cooling of pistons is being discarded by European builders of large units due to the danger of explosion by overheating of the oil in the piston crown." Readers are requested to strike this out of the article as it was published by inadvertence and has no foundation in fact.—EDITOR.



This multiple V-belt on a compressor drive is operating on a comparatively long center distance and a large speed reduction

Operation and Care of MULTIPLE V-BELTS

Causes are given for the troubles sometimes experienced in the operation of multiple V-belts due to improper design, abnormal operating conditions and lack of attention to simple requirements for good service

MULTIPLE V-belts, like other equipment, require a certain amount of attention after installation to obtain the best service from them. Of course, no amount of attention can make a poorly designed drive give good service. The problems of proper design were covered in the article "Selecting Multiple V-Belts to Suit the Drive," *Power*, April 19. Great care should be used to obtain correct design and installation of the belts.

Trouble may be encountered because of using an insufficient number of belts; having the sheave diameters too small for the cross-section of the belts; using sheaves having incorrect groove angles; operating the belts at too-high peripheral speed; and using belts of wrong construction for a given application.

If an insufficient number of belts is used in the drive, the belts will be overloaded and will operate with a higher tension than they were intended for. This produces excessive stresses within the belts and may also cause serious slippage in the sheave grooves. When this occurs high temperatures are produced in the belts, causing the drive to have a short life, and in addition its efficiency will be decreased. Enough belts to carry the load is more economical than too few. The added initial cost of an extra belt or two is surprisingly small, and this additional expense will be repaid by increased belt life and efficiency of the drive.

If trouble is being experienced with a V-belt drive it should be remembered that the load characteristics may increase the work that must be done by the belt 100 per cent above the actual power required for the load. For example, on centrifugal pumps a belt may be selected that has a rating equal to that of the driving motor, where on a crusher the belt should have a normal rating equal to double that of the motor. Failure to recognize the effect that a belt's arc of contact on the sheaves has on its rating has also resulted in overloading. With a 100-deg. arc of contact on the driving sheave a belt is good for only about 75 per cent of its normal rating when making a 180-deg. arc of contact. From the foregoing it is evident that a drive for a large speed reduction or a load that is subjected to serve pulsations or shocks may be inadequate for the application unless careful attention is given to those factors that influence the loading of the belt.

A flywheel on the driven load will generally tend to relieve the drive of shock loads. On the other hand, if a large part of the flywheel effect is in the motor the shock load on the belts will be greatly increased and unless proper allowance has been made for this factor in the belt's design unsatisfactory operation may result.

The smaller the arc about which a belt is bent the greater will be the internal stresses, due to tension and compression, in the belt. In other words, the smaller the sheaves that a belt runs on the harder it will be worked. Excessive bending of the belts, particularly

under heavy loads, overstresses the fabric and causes temperature rises that are detrimental to the rubber in the belt and results in short life. As pointed out in the previous article, the V-belt manufacturers have established minimum size of sheave for given size of belts; sheaves smaller than these should not be used without consulting with the makers of the drive and also by providing liberally in the drive for this factor.

V-belts should not be used on drives where they will be subjected continously to temperatures in excess of 120 deg. F. Neither should they be used when excessive mineral oil will come in contact with them. These conditions are detrimental to the life of rubber, and if it is attempted to operate V-belts where they exist, short belt life and unsatisfactory operation may be expected.

From the foregoing it should not be assumed that V-belts require more care in their selection than other types of power transmission equipment, for they do not. There are certain basic facts that must be recognized if satisfactory service is to be obtained with any piece of equipment. If these requirements are violated, trouble, excessive maintenance cost and short life for the equipment are likely to result. This applies to a flat belt or gear, coupling, V-belt or any other type of drive. The difference in cost between a properly designed drive and one that is inadequate for the application is so small that there is no excuse for selecting the latter.

Multiple V-belts may have sufficient capacity, be of correct cross-section and run on sheaves of ample diameters and yet give trouble if the sheaves' grooves are not of proper design and construction. The grooves should have an angle so that the belts take the load at their pitch lines. They should be so proportioned that the belts ride in a correct position in them. Large grooves allow the belts to run too low in them and may result in turning the edges on the top surface of the belts. Grooves that are too small cause the belts to ride too high and the top surface tends to flatten out and prevent proper seating of the belts in the grooves. Either of these conditions prevents a proper functioning of the belts and reduces their capacity to transmit power efficiently.

A belt should never be allowed to ride on the bottom of the groove, as this will cause it to lose its traction and slip and generate heat. Further, a space between the base of the belt and that of the groove prevents trapping air that, especially at high speed, will reduce the belt's contact and driving power.

The side-wall surface of the grooves must be smooth and their outer edges rounded slightly so they will be free of sharp corners that might cut the belt. There has been failure of V-belt drives due to rough surfaces of the grooves causing rapid wear of the belts. Rough surfaces on the grooves may be caused by improper machining or be due to rusting.

If sheaves are stored their grooves should be covered with a coat of grease to prevent rusting, the same as when protecting journal bearings on shafting. If this is not done the grooves may become rough because of rust before the sheaves are put into service, with a resulting decreased life of the belts. Where a protecting grease has been put onto the grooves, they should be thoroughly cleaned with gasoline before the belts are put into place, as oil and rubber are enemies. If a drive is to be allowed to stand idle for a long

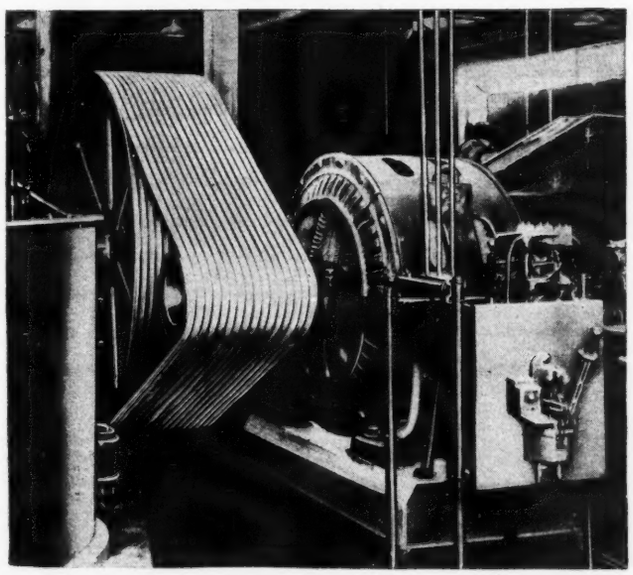


Fig. 1—A 150-hp. induction motor connected by a 16-strand V-belt. This drive is a good example of a short-center large-speed-reduction application

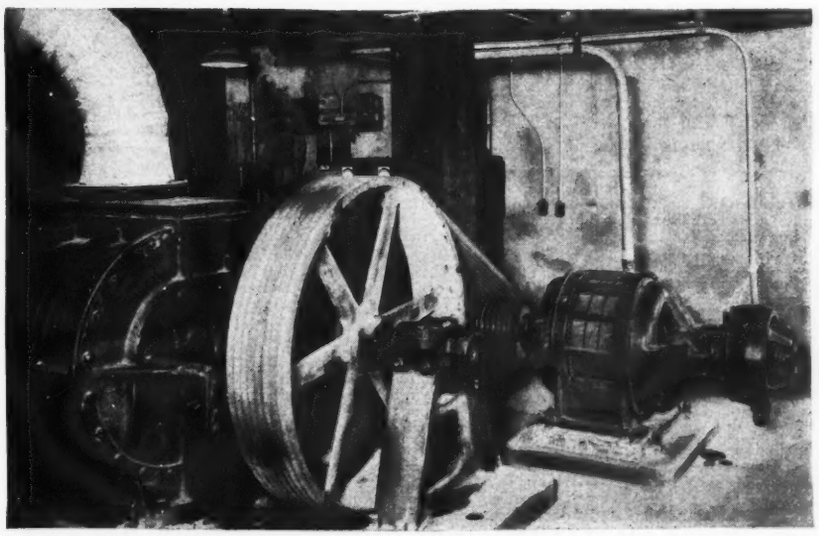


Fig. 2—A 100-hp., 900-r.p.m. synchronous motor with direct-connected exciter connected by a multiple V-belt to a blower which pneumatically conveys shavings from a planing mill to a boiler house

time it is advisable to take the belts off and store them in a cool place and protect the sheave grooves with a coat of oil or grease.

All belts should be loaded equally. To accomplish this the sheave grooves must be machined to accurate size and the belts be of this same size and length. When these conditions are satisfied in the design of the drive and are maintained in operation the load will be distributed equally between the different belts in the drive.

During the first few days of operation there will be some slackening of new belts because of their seating in the sheaves' grooves. This slack should be taken up by adjustment of the shaft centers. As a usual thing any small difference in length of the different belts, which may have been apparent when the drive was first installed, will usually disappear at this time. After the first adjustment the drive should not require further attention for many months.

There are several things that may cause unequal loading of the belts: one belt may stretch more than another; unequal wear of the belts and grooves; and dirty belts and grooves. When one belt sags more than the other it is an indication that this belt has stretched more than

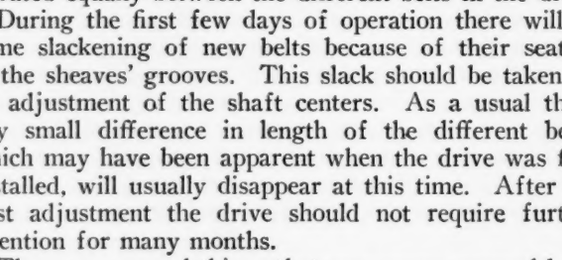


Fig. 3—Belt *C* is operating on an increased pitch diameter

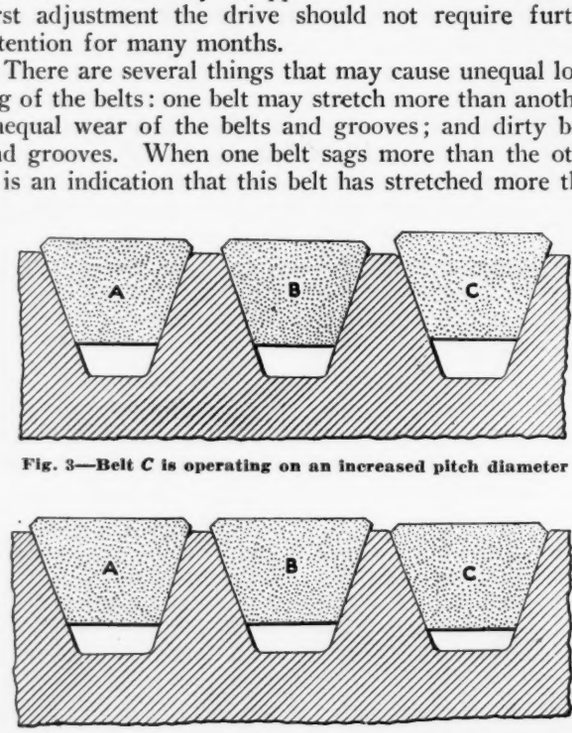


Fig. 4—Belt *C* is operating on a decreased pitch diameter

its companions, or that something has happened to cause its grooves to have incorrect pitch diameters. When a belt has an appreciable sag it may appear to those not familiar with these drives that it is considerably longer than the other. However, this may not be so, for with belts running on a 50-in. center a 0.5-in. slack will cause a 3.5-in. sag. Therefore a slight difference in sag between several belts in parallel is not serious.

A large sag in one or more of the belts of a drive means excessive slippage of the slack belts, a loss of power and efficiency and maybe excessive heating of the faulty belts. When a belt is longer than the others with which it operates, it cannot be given the proper tension to carry its share of the load, which means that it is underloaded and the other belts are taking more than their share.

If the sag is caused due to unequal dimensions of the sheave grooves the matter becomes of more serious moment. Assume that one groove of the driving sheave, such as *C*, Fig. 3, becomes coated with dirt so as to make its belt run on an increased pitch diameter. Belt *C* would then run at a higher peripheral speed than the others. This would cause the load side of the belt to be taken from the driven sheave faster than normal and delivered to that sheave at a higher speed than required. As a result the load side of the belt has an excess tension and the slack side has less than normal tension. The result is that belt will take more than its share of the load and will have to slip in its grooves to compensate for the higher peripheral speed at which it tends to operate.

If belt *C* were running on a reduced pitch diameter due to a worn groove in the driving sheave, as in Fig. 4, it would then tend to run at a reduced peripheral speed over the driving sheave and at normal speed around the driven sheave. This would put the slack side of the

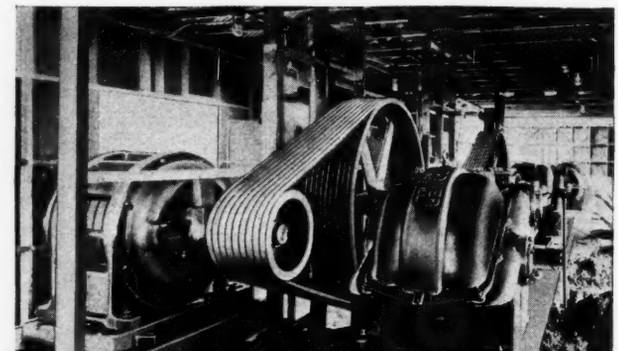


Fig. 5—Pumps in a west-Texas oil-pumping station connected to their motors by multiple V-belts

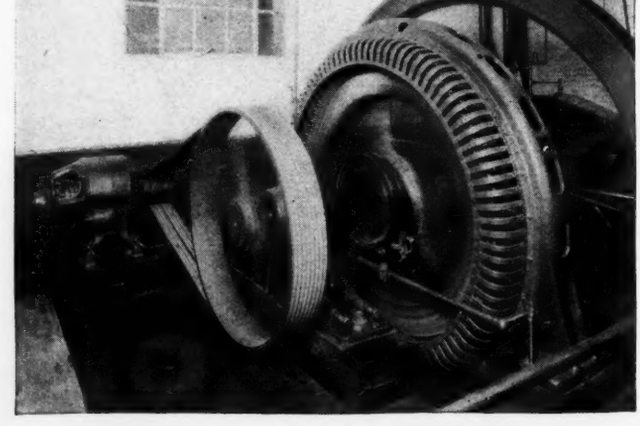


Fig. 6—A 16-kw. exciter connected to the shaft of a slow-speed Corliss-engine driven alternator by a multiple V-belt

In this installation the V-belt is used as a speed increaser, rather than a speed reducer as they are generally applied.

belt under tension and the belt would also have to slip on the driving sheave to compensate for its lower peripheral speed around that sheave. Whenever the belts run on different pitch diameters there must be slippage, and this reduces the efficiency of the drive. Slipping of the belts in the grooves also causes increased temperatures and it may also dangerously overload some of the belts in a group, all of which tends to reduce the life of the drive.

Sometimes trouble is experienced by the slack side of a belt whipping up and down or sidewise. This condi-

tion is generally caused by dirty grooves in the sheaves. It is sometimes due to the belts not having sufficient reinforcement against lateral movement, insufficient body to the belt, or inaccurate grooves. For proper running belts, they and their sheave grooves should be kept clean. This, however, becomes a serious matter only in installations where certain kinds of dirt are present. In a large percentage of the drives the belts and sheaves tend to run clear.

Sometimes V-belts tend to develop abnormally high temperatures when they are in service. This may be caused by slippage of the belts on the sheaves; the belts operating on sheaves that are too small; or, in some cases, heating is caused by the construction of the belt being too soft, resulting in excessive deformation of the belt's cross-section.

When V-belts are installed their sheaves should be properly lined up and maintained that way in service. If this is not done the belts will rub one side of the sheaves' grooves and will cause undue wear of both the belts and the sheaves.

V-belts when properly applied give little trouble. However, they are like all other types of mechanical power-transmission equipment; they must be chosen correctly for the service in which they are to be used and given a reasonable amount of attention.

Acknowledgment for aid in the preparation of this article is made to the Allis-Chalmers Manufacturing Company; Worthington Pump & Machinery Company; L. H. Gilmer Company; Dayton Rubber Manufacturing Company; Gates Rubber Company; Fairbanks, Morse & Company; and Manhattan Rubber Manufacturing Company.

Small Wastes May Accumulate Into Large Losses

PREVENTING losses by preventing leaks offers large opportunities for reducing costs in plant operation. Air, steam, water, gas, electricity and sometimes other services are distributed about plants over wide areas. Because of the length of the distribution systems and the many connections, opportunities for many small losses are present that may total a surprisingly large waste.

All of these services cost money—even water, when pumped out of the ground or from a river by the plant's own pumps, is not free. Power has to be used to drive the pumps and the equipment must be maintained, both of which cost money. If water is allowed to run to waste unnecessary pumping will have to be done, which means an increase in the power used and in wear on the equipment. When it is considered that at 40 lb. per square inch pressure 19,500 gal. of water can be wasted in one month through the equivalent of a $\frac{1}{16}$-in. hole, one realizes what the loss may be through a few apparently inconsequental leaks.

All leaks are not external, where they can be seen. Leaky valves in pumps and compressors may cause large power losses in operating the equipment and in unnecessary use of it. Both increase the cost of supplying the service.

There is a general belief that large losses cannot occur in electrical circuits due to leaks. This, however, is a fallacy that has been proved in many cases.

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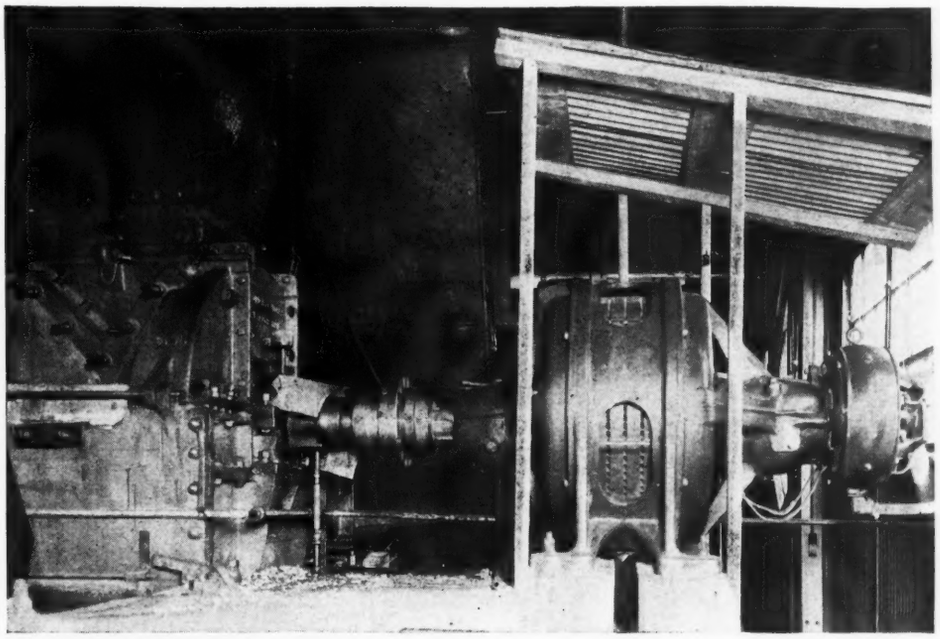
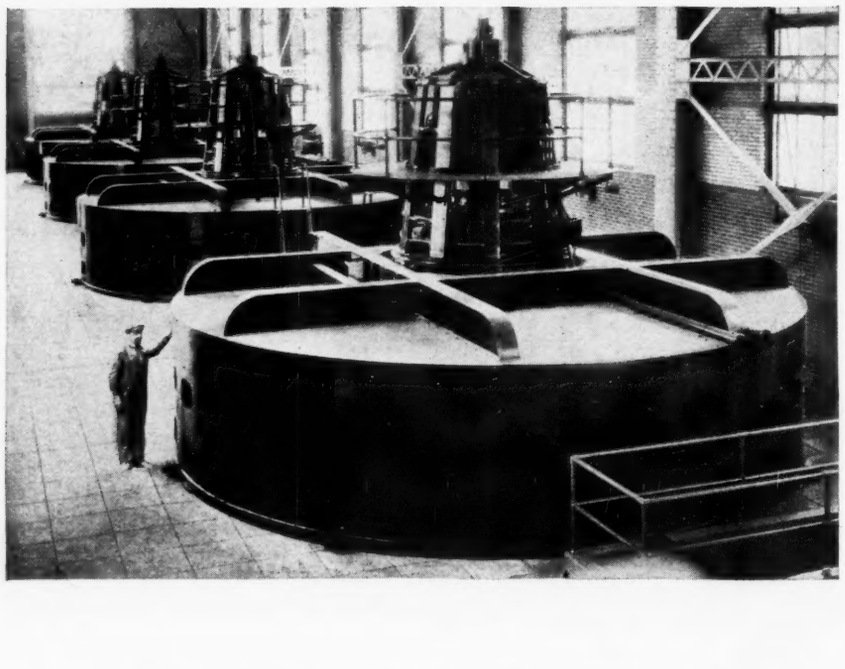


THE ILLUSTRATION shows an installation of a 175-hp., 900-r.p.m., 2,200-volt, 0.8-power factor, G. E. synchronous type of motor driving a fuel hog in the plant of Edward Hines, Burns, Ore. This application involves a high accelerating duty because of the high flywheel effect of the rotating parts of the hog. In addition, there are high peak loads during normal operation



Saluda plant of the Lexington Water Power Company includes four 40,625-kva. 0.80-power-factor generators

Dividing Hydro Load To Obtain Maximum Efficiency

By ALLEN W. REID
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A method for analyzing the discharge-output curves of hydro-electric units to determine the most efficient division of load between two or more generators. This method was applied in the study of test results obtained on the units in the Saluda hydro plant of the Lexington Water Power Company. The wheels were tested by the Allen salt-velocity method and a system of loading worked out that would give the most economic operation for the conditions involved

DURING the past five or six years it has become something of a habit among hydro-electric plant operators to divide equally the load being carried by similar units on the assumption that maximum efficiency is obtained. This assumption is not always justified, particularly when units are operated in parallel at a relatively low output. The saving which may result from a change in the method of parallel operation, alone, may pay an excellent return on the cost of a careful determination of curves of discharge against output. When such curves, within the operating range, are convexed toward the output axis, equal division of load is advantageous. Sometimes the curves contain points of inflection, especially toward their lower ends, and when operating in this section a different method should be used.

A comprehensive discussion of the theory of economical load distribution can be found in a paper by Frank H. Rogers and Lewis F. Moody, read before the Third Annual Hydro-Electric Conference held at the Engineers Club of Philadelphia, March 10, 1925. However, the explanation involves the use of first and second derivatives and in the writer's experience is somewhat beyond the comprehension of many plant operators interested in this subject. It is quite possible to analyze a plant's load by a simple study of the output discharge curve of the unit, without recourse to higher mathematics.

Fig. 1 is a curve of the type having a point of inflection toward its lower end, with its characteristics greatly exaggerated for the sake of clearness. Assume this curve to apply to each of two units. Let P on the kilowatt scale represent the output of each unit. Then each will discharge Q second-feet. Now increase the output of unit No. 1 to P_1 kilowatts and reduce that of unit No. 2 to P_2 kilowatts. The distances PP_1 and PP_2 being made equal, the combined outputs of the units is not changed. It is evident that QQ_1 is greater than QQ_2, therefore more discharge is taken by unit No. 1 than is subtracted from unit No. 2. This results in a net increase in the quantity of water used for the same output and a reduction in efficiency, a condition that is true regardless of where the start-

ing point F is located and the final points F_1 and F_2 so long as the shape of the curve is such that the slope of the chord FF_1 is greater than that of the chord FF_2.

Referring to Fig. 2, in which the curve Fig. 1 has been repeated, select an initial load for each unit of P kilowatts, whose abscissa intercepts the curve at point F midway of the straight line section F_1F_2. As load is added to unit No. 1 and an equal amount taken from units No. 2 it is obvious that until the loads reach P_1 and P_2 respectively, the total quantity of water used will not change, distance QQ_1 being equal to distance QQ_2. Let unit No. 1 carry P_1' kilowatts and reduce the load on unit No. 2 to P_2' the sum of the two loads being the same as originally. Since the curve above F_1 has a longer radius of curvature than the curve below F_2, the chord F_1F_1' will have less slope than the chord F_2F_2'. Consequently, the saving in water discharge Q_2Q_2', of unit No. 2 is greater than Q_1Q_1' added to unit No. 1, resulting in a net saving of water and a gain in efficiency.

The next question is how far apart should P_1 and P_2 be separated to obtain maximum effiicency. It is evident that for each increment added to the output of unit No. 1 the chord of the intercepted section of the curve will have less slope than the chord for the corresponding decrement in output of unit No. 2 until unit No. 1 is supplying P_1'' kilowatts. F_1'' is the point at which a tangent is parallel to the straight portion at the lower end of the curve. Therefore with a total load of $2P$ kilowatts it is most economical to carry P_1'' on one unit and P_2'' on the other. It will not be economical in any case to place on unit No. 1 a greater load than P_1'' kilowatts, since any part of the curve above that point is steeper than any part below it. Consequently, the increment of discharge through unit No. 1 would be greater than the decrement of discharge through unit No. 2, and would reduce the combined efficiency .

Now assume an initial load on each unit of P_a kilowatts, F_a being the intersection of the curve with the straight line $F_1''F_a'$, which has been so drawn that $F_aF_1'' = F_aF_a'$. As load is added on unit No. 1 and taken from unit No. 2 there will be no change in efficiency as long as both units are operating in the straight portion F_1F_2. When the load on unit No. 1 passes P_1 there will start to be a loss in efficiency, since the chord of the intercepted arc will have a greater slope than the corresponding chord applying to the decrement of load on unit No. 2. As the spread between the units is increased, however, a point will be reached where this loss will start to be regained, until when unit No. 1 is operating at P_1'' kilowatts and unit No. 2 at P_a', the efficiency will be just what it was with each unit operating at F_a, chords F_aF_1'' and F_aF_a' being equal both in length and slope.

If we consider as the initial loading of each unit any load P_b greater than P_a a decrease of efficiency will result from spreading the loads to P_1'' and P_b', respectively, since chord F_bF_1'' has a greater slope than chord F_bF_b'. If we start with any load P_c less than P_a a change to P_1'' and P_c' will raise the efficiency, as the slope of F_cF_1'' is less than that of F_cF_c'. Therefore P_a is the point above which the load should be equally divided and below which it should be spread.

It is conceivable that with a combined load such as $2P_b$ or $2P_c$ the shape of the curve might be such that the efficiency could be increased by spreading the loads

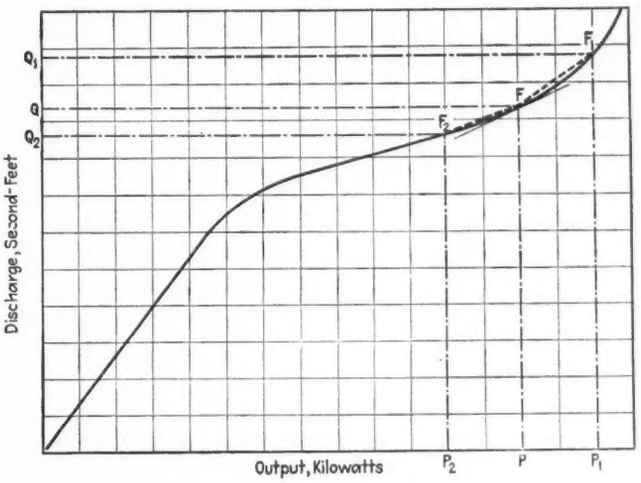


Fig. 1 — Power-discharge curve for a hydro-electric unit. If each unit is carrying a load of *P* kilowatts this will be the most efficient way to supply the load, since if the load on No. 1 unit is increased to P_1 and that on No. 2 is reduced to P_2, the discharge of No. 1 unit increases faster than that of No. 2 decreases and results in a decrease in efficiency.

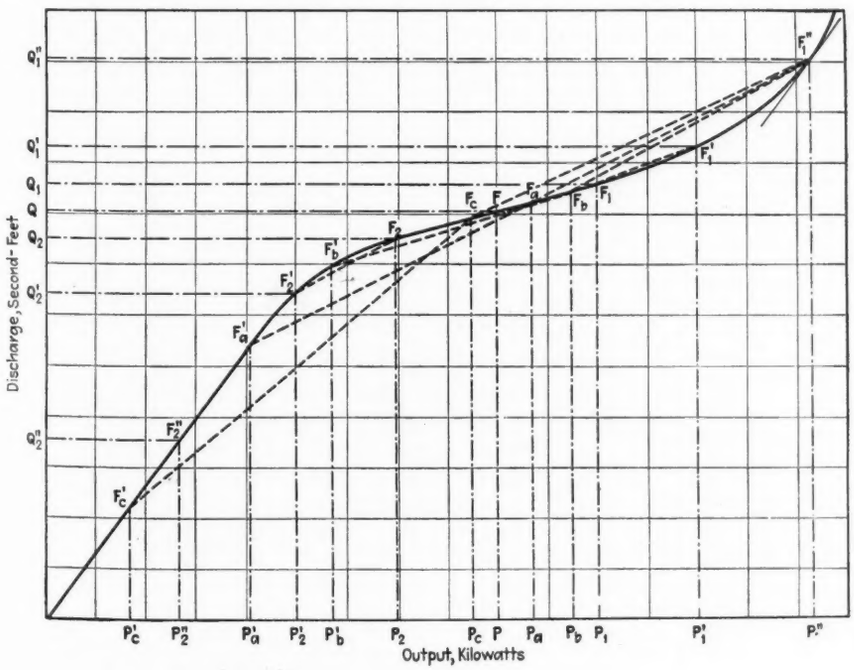


Fig. 2—The curve Fig. 1 repeated but the load *P* on the two units less than in Fig. 1. Under this condition unequal division of the load between the two units gives the highest efficiency

to points respectively somewhat below F_1'' and above F_b' or F_c'. Any such possible gain would be of purely academic interest, since with the amount of curvature of the output discharge curve found in practice it would be very slight.

The foregoing analysis may be easily extended to cover more than two units. Assume three machine in parallel at identical loads, the output of each being less than P_a kilowatts. Considering only two of these turbines, we have already shown that a saving can be made by operating one at P_1'' kilowatts, reducing the load on the other correspondingly. Considering now only the latter unit and the third one, which is still at its original output, the same reasoning will apply, indicating that two units should operate at P_1'' kilowatts and the third should carry the remainder of the load. Let us now assume that the three machines are each carrying like loads greater than P_a kilowatts. Considering only two of the units, we know that if one is raised to P_1'' kilowatts and the other is lowered, a reduction of efficiency will result. Considering the second and third only, it will quite possibly be found that there will be a saving by increasing one load to P_1'' and making a corresponding reduction in the other. The gain may or may not offset the loss incurred by spreading the load on the first two units. Evidently the critical load P_a, if three-unit operation is being considered, will be higher than it has been shown in Fig. 2. In applying the explanation of Fig. 2 to three units it should be borne in mind that a load increment will be divided between two units while a corresponding decrement will be made on one only, and consequently will be twice the length of the former on the power axis. This means that in locating the critical point P_a for three-unit operation the line $F_1''F_a'$ should be so drawn that $F_1''F_a$ is one-third its length, rather than one-half. For more than three units the ratio would be correspondingly reduced.

Fig. 3 shows the line output plotted against discharge for a unit at the Saluda hydro development of the Lexington Water Power Company near Columbia, S. C., as determined by the Allen salt-velocity test. This curve has all the characteristics of that shown in Figs. 1 and 2. On the curve are shown the gate openings corresponding to output. This curve was drawn as accurately as possible to a large scale and the point corresponding to F_1'' in Fig. 2 was found to lie at 75 per cent gate opening. The point of intersection F_a was then determined by trial and error, assuming a position for it and computing the coordinates of point F_a' until they were found to lie on the curve. It was located at 56 per cent gate opening for two, 61 per cent for three and 64 per cent gate for four units.

Fig. 4 has been drawn to show the discharge from the Saluda plant for various loads carried by one unit, as far as possible, by two units with the load equally divided and, by two units, one operating at 75 per cent gate and the load varied on the other. The facts brought out by this curve are particularly important to the operators of this plant, since the output has been sold under conditions which place the loading of the units largely beyond the control of the operating company and necessitate frequent operation of two units in parallel at outputs where equal division of load is uneconomical.

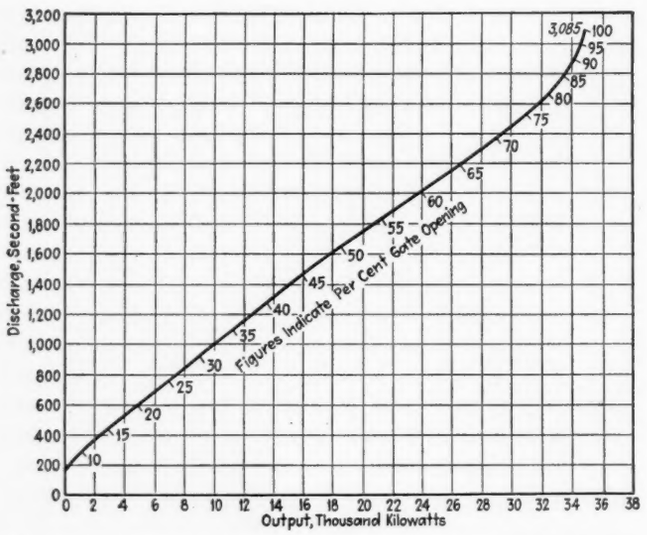


Fig. 3 — Power-discharge curve for one of the 55,650-hp., 180-ft. head, 138-r.p.m. turbines in the Saluda plant of the Lexington Water Power Company. The curve was obtained by water measurements made by the Allen salt-velocity method

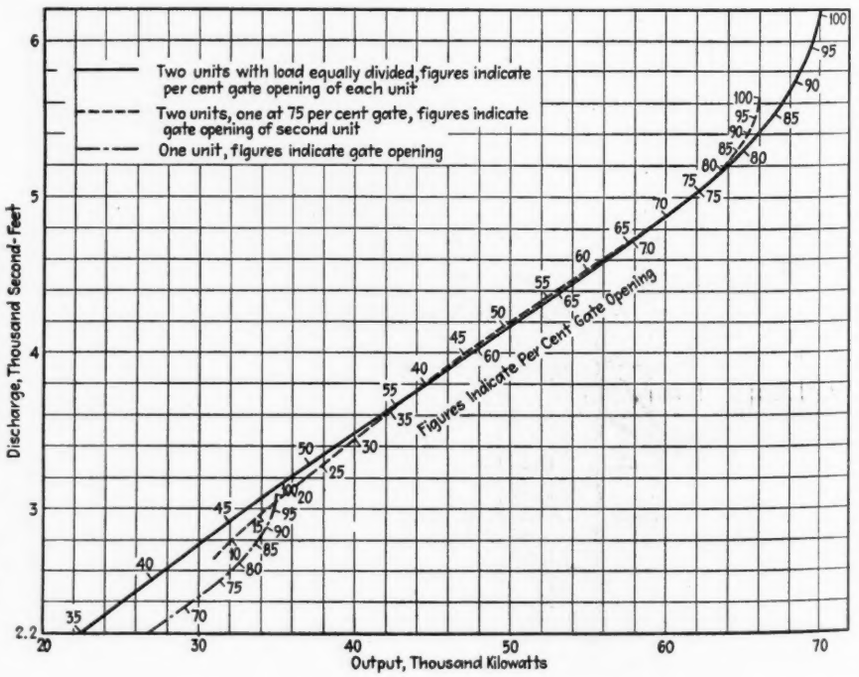

Two units with load equally divided, figures indicate per cent gate opening of each unit
Two units, one at 75 per cent gate, figures indicate gate opening of second unit
One unit, figures indicate gate opening
Discharge, Thousand Second-Feet
Output, Thousand Kilowatts
Figures Indicate Per Cent Gate Opening

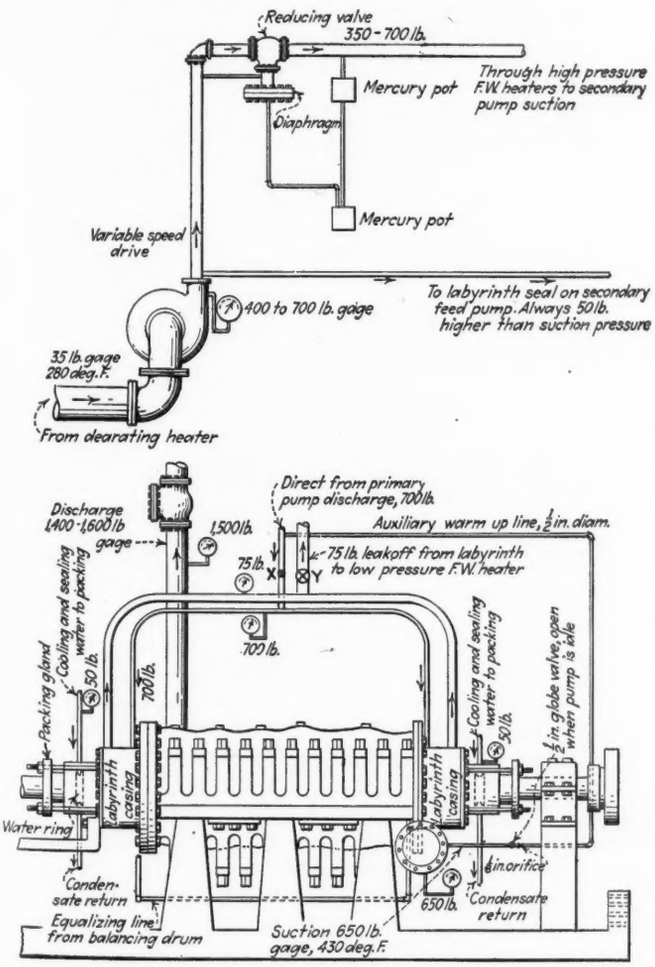
Fig. 4 — The discharge from the Saluda plant for various loads carried on one unit as far as possible, by two units with the load equally divided and, by two units one operating at 75 per cent gate and the load varied on the other

PRACTICAL AIDS TO OPERATION

Maintenance on High-Pressure Boiler-Feed Pumps

AFTER a year's operation in a high-pressure central station it was found necessary to make several important changes in the feed-water system to the boilers, principally to lower the maintenance on the high-pressure feed pumps.

The feed water was delivered from the hotwell and storage tanks through a closed feed-water heater to a deaërating heater. From here it was taken by a primary feed pump and passed through two high-pressure closed heaters receiving steam bled from the turbines. The feed-water passed from these two heaters to the suction of a secondary feed pump, which ran at constant speed and discharged the feed water through the economizers to the boilers.


Reducing valve 350-700 lb.
Through high pressure F.W. heaters to secondary pump suction
Mercury pot
Diaphragm
Mercury pot
Variable speed drive
400 to 700 lb. gage
To labyrinth seal on secondary feed pump. Always 50 lb. higher than suction pressure
35 lb. gage 280 deg. F.
From dearating heater
Direct from primary pump discharge, 700 lb.
Discharge 1400-1600 lb gage
1500 lb.
Auxiliary warm up line, ½ in. diam.
75 lb.
75 lb. leakoff from labyrinth to low pressure F.W. heater
700 lb.
Packing gland
Cooling and sealing water to packing
50 lb.
700 lb.
Cooling and sealing water to packing
50 lb.
½ in. globe valve, open when pump is idle
labyrinth casing
labyrinth casing
Water ring
Conden-sate return
Equalizing line from balancing drum
Suction 650 lb. gage, 430 deg. F.
650 lb.
⅛ in. orifice
Condensate return

Arrangement of reducing valve on primary pump discharge and auxiliary warming up line on idle secondary feed pump

The primary feed pump discharge had a possible pressure variation of 350 lb. between the limits of 400 and 750 lb. gage pressure, the feed water being at about 280 deg. F. The secondary feed pump received the water from the high-pressure heaters at 430 deg. with full load on the turbines. Duplicate pumps were installed and practice had been to keep the valves on the idle pump open.

It was found that excessive cutting of the metal in the labyrinth gland of the idle pump was taking place by the high-pressure, high-temperature water leaking through to the leakoff line. Another difficulty was that the life of the labyrinth was not as long as that expected due to the high temperature at which it was running with the 430-deg. water leaking through it. The following changes were made to reduce the leakage through the idle pump to a minimum but still keep it as near to operating temperature as possible, and also to lower the labyrinth temperature of the pump that was in service.

A reducing valve was placed in the primary pump discharge line between the primary pump and the high-pressure feed-water heaters. The high-pressure labyrinth sealing line on the secondary feed pumps was then connected directly to the primary pump discharge before the reducing valve. By this arrangement a 50-lb. differential was maintained across the reducing valve at all times regardless of the discharge pressure of the primary pump. The labyrinth was now sealed by water at a pressure 50 lb. and 150 deg. lower than the water that was leaking by the balancing drum. There was a tendency for the cooler water at the higher pressure to leak into the pump instead of the hotter water to leak out through the labyrinth.

The following changes were made in the idle secondary feed pump. The discharge, suction and labyrinth sealing valve X were kept closed. A $\frac{1}{2}$-in. auxiliary warming line was run as shown from the pressure side of valve X to the suction side of the valve in the suction line of the secondary pump. A $\frac{1}{8}$-in. orifice nipple made from round steel stock was placed in this line with a $\frac{1}{2}$-in. globe valve. This valve was opened and left open while the pump was out of service, so that a slow circulation of warm water was continually passing through the pump, labyrinth and out the leak-off line, keeping it at a temperature high enough to allow it to be brought into service with no delay or damage from being at too low a temperature. This water passing through the labyrinth for days at a time was not hot enough or at sufficient velocity to cause appreciable cutting.

If this labyrinth becomes worn considerably owing to the cutting action of the water, a high leak-off pressure will be noticed and the primary pump will have to be operated above normal speed for the boiler output, owing to the bypassing effect.

HARRY M. SPRING.

Boston, Mass.

Phantom-Coil Signal Circuits On Telephone Lines

IT OFTEN HAPPENS that an extra telephone or signal circuit is desired from a remote location for registering the height of water or for other purposes, but the circuit is not run because of the cost involved. Where there are a pair of telephone wires available, especially about plants and industries, it is a simple matter to use what

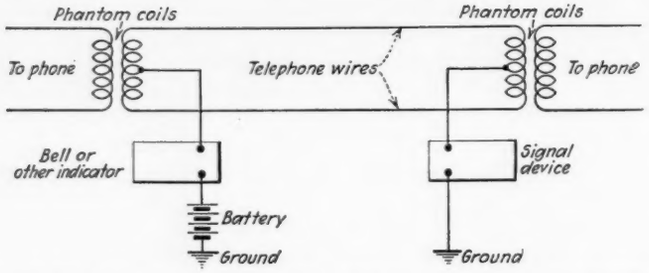


Fig. 1—Diagram of phantom coils used on grounded return circuit

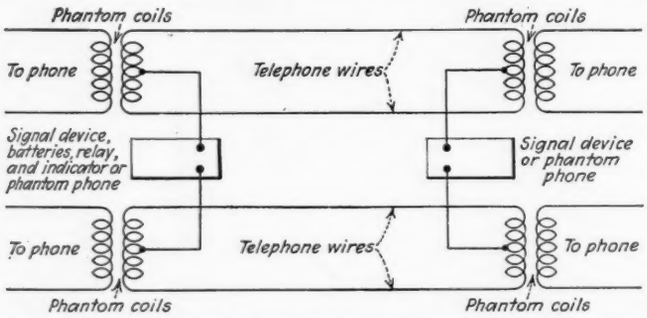


Fig. 2—Diagram of phantom coils used on two telephone lines

is generally known as repeating or phantom coils that are in common use by the telephone companies.

The cost of these coils is comparatively low and as a rule only two are needed. As they are built to stand more than 110 volts direct current, they can be used when properly installed with almost any direct-current supply, either batteries or generator current. They will allow a signal circuit to operate through the telephone line without interference to telephone conversations or bell ringing. This superimposed current may be used to operate suitable relays for indicating any type of condition desired through long distances.

The advantages of phantom coils are apparently for distances of 1,000 ft. and longer. When other lines are available, such as two telephone circuits of two wires each, a third telephone circuit can be made available by using four phantom coils, or the coils may be used to obtain a signal circuit without ground connections. Two combinations of circuits are given in Figs. 1 and 2. Other connections and uses are available with these coils.

Silverton, Colo. HAMMOND MATHEWS.

CURRENT COMMENT

Foundation Bolts for Compressor

WITH REFERENCE to the letter by A. C. Giger in the March 29 number of *Power,* in which he shows a method of securing foundation bolts by means of wedges, he would have obtained just as good results and saved considerable time and labor by eliminating the wedges and upsetting the end of the bolt sufficiently to hold a washer. Inasmuch as the holes were drilled 4 in. in diameter and the bolts were 1½ in., a standard bolt head and washer could have been used. Mr. Giger may have had some good reason for using the split end and wedge type of bolt, but it is not clear from the text. J. E. NOBLE.

Toronto, Ont.

Suggested Remedies for Overcoming Corrosion and Plugging in Preheaters

IN JAMES F. MUIR'S interesting article in *Power,* March 29, 1932, it is pointed out that the great economic value of air preheaters as boiler appurtenances cannot be secured without a certain amount of "grief" from corrosion and plugging.

There cannot be the slightest doubt that both of these are factors which must be reckoned with. As Mr. Muir so aptly puts it, "corrosion and plugging are two well-known demons that are running wild all around the 'box of tricks.'" There is, however, a distinction to be made. Corrosion troubles are the direct result of low exit gas temperatures, while plugging may take place where exit gas temperatures are above or below the dew point.

To insure against corrosion, the exit gas temperatures from an air preheater should not be dropped below 250

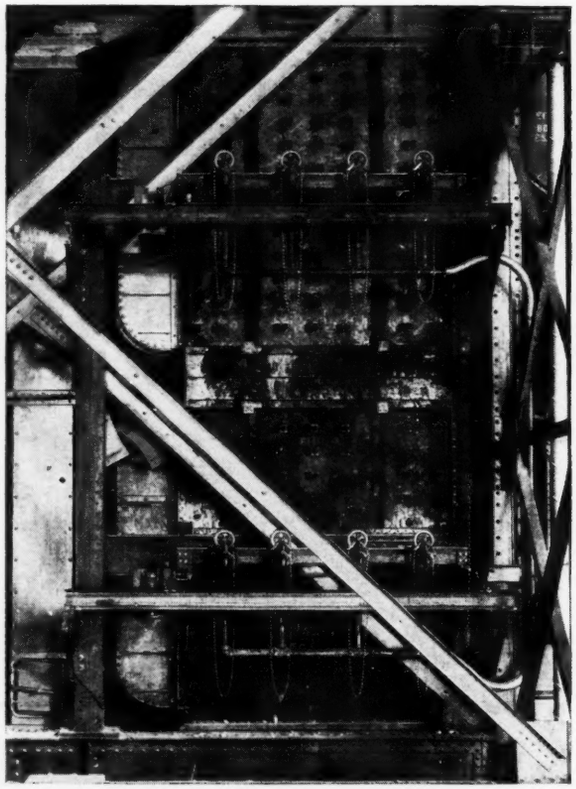
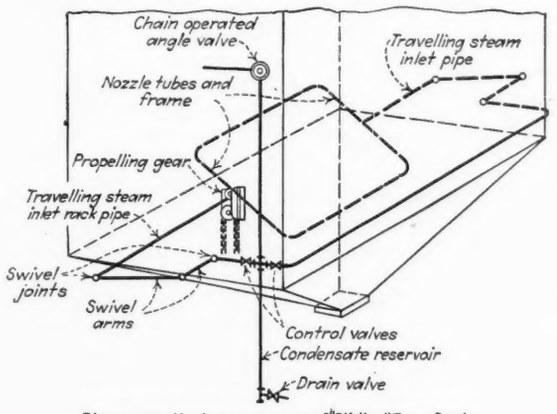


Fig. 1—Application of soot blowers to a plate-type preheater

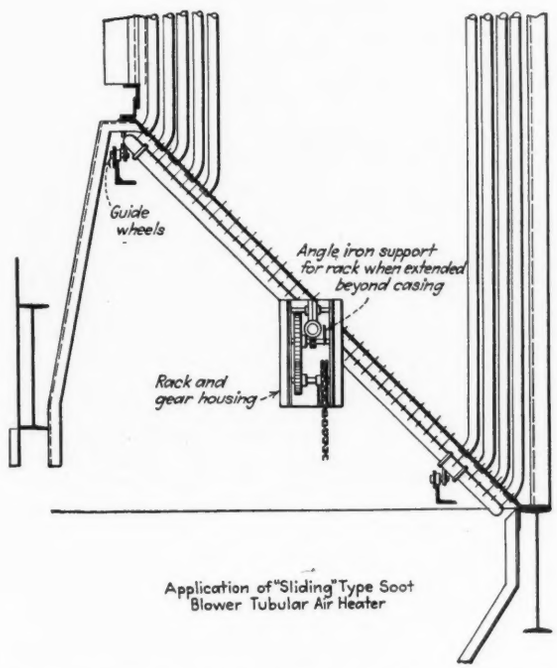
deg. F., which is close to the dew point of the usual boiler gases. Before this fact was determined, a number of air preheaters in this country became useless because of corrosion in two or three years of operation. It has been found that in the majority of cases the installation of air preheaters may be justified with final temperatures of approximately 300 deg. F., but where the economic limit of final gas temperatures is below this point, especially below 250 deg. F., it is necessary to give special attention to the construction of the preheater; that is, materials must be found which will satisfactorily resist the ever-present tendency toward corrosion.

Where exit gas temperatures are too low, moist deposits form on the upper, or cool, end of the tubes in

a tubular air preheater. Dilute sulphurous and sulphuric acids are present in these deposits. As the deposits build up they soon acquire sufficient fluid body to flow down the tubes in the case of an air preheater with upward gas flow. As these deposits flow down the tubes, or as gas temperatures increase due to increased boiler ratings, they dry enough to be baked to the tubes. Then, sooner or later, the tubes are plugged solid, and, under the mass, corrosion is taking place. Steam- or air-jet soot blowers are undesirable for installation where exit gas temperatures are below the dew point, not because they increase corrosion, but because clogging is of such nature that it does not readily yield to soot blower operation.



Diagrammatic Arrangement of "Sliding" Type Soot Blower with Steam Supply Piping



Application of "Sliding" Type Soot Blower Tubular Air Heater

Fig. 2—Diagram of blower applied to tubular air preheater

It has been claimed that steam soot blowers promote corrosion by coating the tube surfaces with moisure. This belief cannot be justified by fact. The water condensed from the steam required to operate an unusually large air preheater soot blower installation does not exceed 2,400 lb. per eight-hour blow. In most cases it is required to operate the soot blower but once every twelve hours on the average preheater installation. This represents but a small percentage of the total amount of moisture carried over by the combustion gases.

In the case of good grades of Pocahontas coal the moisture content is 0.76 per cent, to which must be added the water represented by the combustion of the hydrogen, which may be present in the coal to the extent of 4.2 per cent. It will be seen, therefore, that a boiler burning 12,000 lb. of coal per hour will carry over 37,040 lb. of water in eight hours from the fuel and its combustion alone. In addition, the moisture present in the air required to complete combustion amounts to a considerable weight. At 60 deg. F. and 50 per cent relative humidity every cubic foot of air (0.076 lb.) contains 3 gr. of moisture. Figuring an average requirement of 17 lb. air to complete the combustion of one pound of coal, it will readily be seen that at 7,000 gr. per pound 9,650 lb. of additional water is introduced in eight hours. This gives us a total amount of water introduced in the products of combustion of 46,690 lb., whereas under maximum conditions the soot blowers do not introduce more than 2,400 lb. in the same time, or but 5.1 per cent of the total moisture present in the gases of combustion.

That the small percentage of water introduced by a steam soot blower is not a factor in connection with corrosion is borne out by the fact that both steam and air have been used as the cleaning fluid without any apparent difference.

Clogging, under normal conditions—that is, where exit gas temperatures are not under 300 deg. F.—can be, and is, satisfactorily prevented by the proper installation and operation of mechanical soot blowers.

In one instance at least, successful cleaning has even been obtained where exit gas temperatures are 290 deg. F. and slightly lower. Given sufficiently high steam or air pressure to impart proper nozzle velocities, a blower of the right design for each type of preheater, and systematic operation of the blower at proper intervals, an entirely satisfactory cleaning may be obtained. To the writer's knowledge, in only two instances have unsatisfactory cleaning results been reported, and both of these were due to exit gas temperatures below the dew point.

In one large central station the tubular air preheaters were put into operation with no provision for cleaning other than the hand lance. The boilers were fired with pulverized coal and were run at very high temperatures, so that large quantities of fly ash were carried over into the preheater, and plugging was particularly troublesome. It was found necessary frequently to cut out the preheater at the end of a single week's operation to clean a large number of plugged tubes. On occasion it was found necessary to pass a regular tube cleaner through the tubes to cut out the accumulation packed into them. The entire preheater was turbined on several occasions. A soot blower was installed, with the result that out of the total of 1,080 tubes making up the preheater only two were found to be plugged. No supplementary hand-lancing whatever has since been needed on this preheater.

Fig. 2 is a diagrammatic sketch of the type of blower used in this case, showing its application to a tubular air preheater. Blowers of this type have been built up to 21 ft. in length.

Fig. 1 is a photograph of an installation on a plate-type preheater, where the number of spaces was so great that blowing was required in two positions to prevent over-nozzling the elements. Air is the cleaning fluid.

Detroit, Mich. G. L. DAVIS.

READERS' PROBLEMS

SINGLE-PHASE ROTARY CONVERTER—*There is a 5-kw., 4-pole, 750-r.p.m., compound-wound, 220-volt direct-current generator in our plant. Would there be any objection to putting two slip rings on the armature of this machine and, by properly connecting these rings to the armature winding, operating the machine as a 60-cycle, single-phase rotary converter?* S.A.

One of the chief objections to operating the machine as a single-phase, 60-cycle rotary converter is that it will have to run at 1,800 r.p.m. It probably will be unsafe to operate the machine at a 140 per cent increase in speed.

From purely electrical considerations it is possible to tap the armature at two diametrically opposite points and operate the machine as a single-phase converter. A single-phase rotary converter is not very stable at best and when operated without a damper winding in the polefaces it may give trouble because of excessive armature oscillations.

To keep the iron losses at a reasonable value at the higher speed it will be necessary to reduce the flux density in the field poles. To obtain 220 volts direct current at the commutator at full load will require about 170 volts on the slip rings.

REINFORCING STRAPS ON WELDED PIPING—*We are planning the specification of oxy-acetylene welding for an extension of our high-pressure steam piping (225 lb. pressure). Some numbers of our engineering staff insist that all welded butt joints in these lines should be reinforced with welded straps. Is this necessary or desirable?* H.N.F.

From the safety point of view there is little to be said for the use of reinforcing straps. The strength apparently added by the straps may be an illusion. They do invariably add expense and partly cancel certain great advantages of welding—smoothness, good appearance and ease of insulation.

On the strength basis alone the objection to straps is that they tend to set up unknown stresses due to differential expansion and contraction in the welding process. Similar strains may be set up when steam is admitted to or shut off from the pipe. Much of the troubles experienced with flanges and flange bolts on high-temperature steam lines is due to heavy projecting masses of metal that lag in temperature when the pipe is rapidly heated or cooled.

Remember, first, that piping has a high factor of safety against lengthwise rupture; second, that the factor against circumferential rupture is twice as great; third, that a weld made by a properly tested welder under proper procedure control will show the full strength of the base metal.

If you can't get good welders don't weld the high-pressure lines. If you can, weld them without straps and the job will be perfectly safe, better-looking and far less costly.

ENGINE OF TURBINE REDUCING VALVE—*Why is the steam delivered by a reducing valve somewhat superheated, whereas an engine or turbine supplied with the same steam will generally have a moist exhaust?* W.J.D.

The question is not difficult to answer if it is approached from the angle of heat drops. When steam is expanded through a nozzle or throttle some of the heat in the steam is turned into work. This work appears first as the kinetic energy or velocity of the steam leaving the nozzle. In a turbine this is allowed to do work and the steam never regains the heat it lost.

In a reducing valve, however, there are no turbine blades and the velocity produced in the nozzle is all wasted in eddy currents, which, in turn, transform the energy back into heat.

If, then, the steam is studied a little way beyond the reducing valve, it will be found to have almost exactly the same amount of heat as it had when it entered the reducing valve. There is a little radiation, but it is too small to be of any practical importance.

If the steam entering the reducing valve is dry, saturated, it will be somewhat superheated when it leaves the valve. The reason is that saturated steam at the lower pressure has a smaller amount of heat than at the higher. Since the final heat is the same as at the start, the steam leaving the reducing valve must pick up some superheat.

The case of the engine is like that of the turbine. Some of the heat of the steam is turned into the work delivered to the piston. This never returns to heat the steam. Therefore, the exhaust of the engine will have less superheat than that of the reducing valve and will, in most cases, be wet.

RUSTPROOFING IDLE ENGINE—*We have in our plant a standby engine which is seldom used. Is there a way to keep the polished parts of the engine bright and free from rust?* R.B.

By covering the metal with colorless linseed-oil varnish, a fat or colorless spirit lacquer protection against oxidation may be secured. As it may not be desirable to coat the working parts of an engine with varnish or lacquer, smear the cleaned surface with a mixture of 1 oz. of camphor dissolved in 1 lb. of melted lard and mixed with enough fine black lead to give it color. After 24 hr. rub the surface of the metal clean. This treatment, it is claimed, will keep the metal bright for months under ordinary conditions.

TWO MOTORS DRIVE THE SAME LOAD—*In our plant there is a lineshaft from which several machines are driven. On some days the load on this shaft is about 20 hp. and on others nearly 50 hp. We should like to use two 25-hp. shunt motors to drive the shaft, so that during light-load periods one motor can be used and when heavy loads exist the two motors can be connected. Is it possible to operate the two motors on this load and have the load divided equally between them?* A.T.R.

The two shunt motors may be used to drive the load if they are of the same design and manufacture. If one motor tends to take more load than the other, the motor taking the smallest share of the load can be made to take more by connecting an adjustable rheostat in series with its field coils. A slight weakening of its field should be sufficient to make the motor take its correct share of the load. To keep the load divided equally between the motors it is necessary that they be maintained in good condition. For example, if the brushes and commutator on one motor were to get into poor repair, it would cause that motor to shirk its share of the load.

If trouble is experienced in making the motors divide the load properly between them, increasing the resistance of the armature leads will increase the speed-drop characteristic of the motors and will tend to assist in balancing the load.

MOISTURE IN AMMONIA MAKE-UP—*We operate a 45-ton ammonia compression refrigerating plant, and have used for make-up, ammonia containing 0.05 per cent moisture. It has become possible for us to obtain anhydrous ammonia from our own plant which contains as much as 0.62 per cent moisture. Is this likely to cause trouble?* R.E.M.

If an appreciable quantity of make up ammonia containing 0.62 per cent moisture is used loss of capacity and low suction pressures will probably be encountered.

The moisture contained in the ammonia passes with it through the expansion valve into the evaporating coils. Here the low temperature freezes the moisture, which will collect as snow on the coil surface, generally around the expansion valve. The collection of snow is cumulative, so that in time the expansion valve may become so clogged as to prevent the passage of the amount of ammonia required to accomplish the desired refrigeration.

For every 100 lb. of ammonia containing 0.62 per cent moisture enough snow would be formed in the evaporator to completely fill approximately 10 in. of 1½-in. pipe.

Another effect of snow on the inside surface of the evaporator coil is to decrease heat transfer, making lower suction pressures necessary.

Advisability of Blocking Off Stoker Retort

Readers answering question of April 26 list possible difficulties in suggested plan. Tests proposed stress CO_2 measurements

I HAVE a 350-hp. Stirling-type boiler served by an underfeed stoker four retorts wide. The load on the boiler is seldom over 100 per cent of rating and most of the time between 35 and 50 per cent. What, if any, will be the effect on the water circulation within the boiler when one of the outside retorts is blanked off, the boiler being served by the remaining three retorts? Would any fuel be saved? About how much would be saved? The boiler is in service 24 hr. per day and generates steam at 180 lb. gage, no superheat. Feed water is about 85 per cent returned condensate and 15 per cent of raw make-up. Coal used is Wyoming slack. S.L.W.

Will Unbalance The Heat Absorption

IN OBSERVING a series of tests on a cross-drum sectional-header boiler, fired with an underfeed stoker, I had an opportunity to note the effects of uneven fire conditions on water circulation within the boiler. Four thermocouples were installed at the top of the first pass and four at the gas outlet. When, for any reason, the fire was hotter on one side of the stoker than on the other, the thermocouples in both first and last passes on that side of the boiler indicated higher temperatures than the corresponding thermocouples on the opposite side.

At the same time the water gage on the end of the drum over the hotter portion of the fire indicated somewhat higher water level than the gage on the opposite end of the drum. These effects were so marked that it was possible for the men reading the gas temperatures and water levels to detect uneven fire conditions as soon as the firemen.

This indicated that the gases did not mix sufficiently in passing through the boiler to prevent more heat being absorbed in the boiler tubes on the side of the hotter fire. Naturally, the first-row tubes nearer the hotter portion of the fire absorbed the greater portion of the radiant heat. Hence the mixture of steam and water in the first-pass tubes on the hotter side of the boiler contained a greater proportion of steam than that in the corresponding tubes on the other side. The difference in density between the water in the tubes having downward flow and the mixture in the tubes in which the flow was upward was greater on the hotter side of the boiler, as further indicated by the higher water level on that side. Hence it is reasonable to assume that the circulation was more rapid on the hotter side of the boiler.

Similar conditions would be set up in the boiler in question if one of the outside retorts were blocked off, since the effect of having the active retorts placed unsymmetrically about the centerline of the boiler would be similar to the effect of an uneven fire. However the uneven circulation probably would not cause any trouble, especially at the low ratings at which the boiler is operated.

There probably would be no saving in fuel. The only possible beneficial effect of blocking one retort would be a slight reduction in the amount of excess air, due to the reduction in grate area. And this might be offset by an increase in combustible in the ash. Unfortunately, the older types of underfeed stokers were not generally provided with means for preventing air from passing through the burned-out ash on the lower portion of the grate. The only manner in which excess air can be reduced at low ratings is to adjust the moving grates so that the bed of burned-out ash is quite thick.

Although the scheme proposed would not have any seriously detrimental effects, it probably would not have any advantages. C. A. BUTLER, JR.

Kansas City, Mo.

A Question for Our Readers

OUR POWER is furnished by a condensing turbine bleeding to process at 5 lb. pressure. Throttle steam and bled steam are metered. High-pressure steam costs are figured monthly. To reduce consumption it is proposed to charge manufacturing departments monthly for their actual use of power and bled steam (and, of course, high-pressure steam also). The most reasonable suggestion, apparently, is the following: Without attempting any elaborate thermal computations, bill bled steam at the month's unit cost of live steam minus an arbitrarily fixed 5 or 10 per cent. Credit the steam so sold to the turbine to get the net cost of electricity.

One possible objection to this plan is that it will cause the cost of of electricity to vary greatly from month to month. Will we not get complaints from the production departments in months when the unit cost of electricity goes way up because less is made as a byproduct? Would it pay to avoid this difficulty by setting up the power plant as a separate "business," furnishing steam and electricity at fixed rates designed to leave a little profit at the end of a year's operation, but not necessarily to make money in any given month? I would be glad to get practical suggestions from POWER *readers in this connection.* G.E.A.

Suitable answers from readers if received promptly, will be paid for when published. Typewritten replies should preferably be double spaced.

Make Test for CO_2

MY SUGGESTION to S.L.W. is to take a number of readings for CO_2 with an Orsat while operating the boiler at its usual ratings, both high and low.

If CO_2 readings are high with low operation there is nothing to be gained by blocking off one retort of the stoker, but if CO_2 readings are low at low boiler rating and the stoker appears to be able to carry its load easily at maximum rating, then it would be profitable to block off one retort, making certain that all air is cut off from passing through the dead section. If this air is not cut off there will be a loss of efficiency due to the excess air entering the furnace through the dead section.

It is possible that if the peak loads last only a short time each of the outside retorts could be cut off with improved results. However, the second should not be cut off until operation has been studied with only the first cut off.

The boiler circulation should not be affected sufficiently to cause any concern and it is questionable whether the effect can be noticed at all, although this will depend to some extent on the height of the setting.

If no Orsat is available locally, correspondence with a maker of recording CO_2 instruments may result in an instrument salesman advising where one may be rented or borrowed for a few days, especially if an effort is being made to show the man in the front office what the installation of a recording CO_2 instrument would enable his firemen to do in the way of saving fuel, provided it is continuously and intelligently used after the novelty has worn off.

Brooklyn, N. Y. IRA A. BUTCHER.

Grates May Burn Out

S.L.W. suggests the possibility of blanking off one of four retorts of an underfeed stoker. This idea is not feasible, since the air spaces uncovered by lack of fuel would produce the same effect as holes in the fire and reduce the over-all efficiency. If the air spaces are plugged directly in front of the unused stoker retort it is possible that the grates will burn out. The air through the unused portion of grate, if the retort is not plugged, would create channelling through the boiler and possibly unequal expansion, with its attendant bad results. In any event, no fuel would be saved.

If the boiler is properly equipped with a CO_2 meter and a flow meter the results of a plugged retort could be readily seen. G.E.L.

Parlin N. J.

Commercial Uses of Pulverized-Coal Ash Studied by Detroit and Cleveland Companies

IN AN EFFORT to find some use for pulverized-coal fly ash, the Detroit Edison Company and the Cleveland Electric Illuminating Company have been investigating its commercial by-product possibilities. Results to date, as published in the April report of the Prime Movers Committee of the National Electric Light Association (Publication No. 210), show that out of some twenty uses tried only one appears to have commercial value, namely, as a mineral aggregate in sheet asphalt.

The investigations of both companies have followed three main lines of use, suggested by the more pronounced characteristics of the material. The ash has been tried as an inert filler, as an abrasive material and as a natural cement. In addition the Cleveland company has worked out a method of extracting its iron content.

Both companies agree that most promising of the filler applications is the use of the ash as a mineral aggregate material in sheet asphalt, replacing limestone or silica dust which are generally used at present. This use appears to have commercial value, and several tons of ash have been sold for the purpose.

Other successful, but commercially doubtful, applications include use in the manufacture of Portland cement, as a foundry material, in insulating bricks and building blocks, as a surfacing material for asphalt paving, in Haydite concrete and as a filler in paint. The first named use required more ash than was available at the Detroit Edison Trenton Channel plant, while the other applications suffered from too small market demands.

The unsuccessful applications include use in common brick, lime brick and cinder blocks; as a rubber filler; as a soil corrective in fertilizer; in roofing material, thin-wall tile and acoustical plaster; as a petroleum filter; in sodium silicate blocks; as an abrasive material; in sintering; and as a substitute for sand in building.

Commenting on the use of fly ash in the building block field, the Detroit Edison Company states: "It was found that the ash has some puzzolanic properties similar to some volcanic ashes. Laboratory tests showed that the amount of cement used in a standard concrete mix could be cut as much as 22 per cent if replaced by an equal weight of ash without affecting the ultimate strength of the concrete. It has the disadvantage, however, in decreasing the early strength. The ash concrete did not reach the strength of the standard mix until after 30 days. The decreased cost of the diluted mix, however, seemed to indicate that a market might be found in the non-load-bearing building block field. Experiments were made, using various types of block and tile, which tended to bear out this assumption.

"The present slump in building activity has prevented the further study of the project at this time."

The report of the Cleveland Electric Illuminating Company contains the following remarks on the extraction of iron:

"Of the various constituents of the ash, the iron, which is present to the extent of 10 to 15 per cent calculated as metal, is most easily separated. Chemical and magnetic separation have been employed for the extraction of the iron. . . . For chemical extraction, plant investment and depreciation would probably be high. On a laboratory scale about 75 per cent of the iron in the ash can be extracted by chlorination. By magnetic separation about 6 to 10 per cent of the ash can be separated into a product which contains 50 to 60 per cent metallic iron, the chief impurity in this product being silica. This magnetically separated material is on a par with a good grade of natural ore and could be used as a starting point in the manufacture of ferro alloys. Because of its finely divided state it would have to be sintered or briquetted if it were used in an ordinary blast furnace. When the magnetic material is melted and then allowed to solidify, it makes a fairly good electrical conductor and may find use as resistance rods for low or medium temperature work. It may prove useful for making electrodes for certain purposes."

[Another promising use not mentioned in the report but apparently successful, is in the manufacture of a hard surface brick by the Rostane Process as developed in the chemical laboratory at Purdue University—EDITOR.]

▼ ▼ ▼

Supplying Heat to Processes

By A. J. STEVENSON

MANUFACTURING processes have become so involved and supply of heat at a given temperature is so important that a careful study of each requirement must be made to find the most economical medium of heat. There are three methods in general use by which heat may be supplied, namely, steam, electricity and direct firing with gas or oil.

When steam is available it may be used for supplying heat to ovens for relatively low temperatures, where temperature distribution is not so important. When relatively high temperatures from 275 to 300 deg. F. or above are required and close temperature distribution as well as close temperature control is desired, electric heat should be used. When the products of combustion such as moisture CO, etc., are not detrimental to the process, gas or oil may be used. The existing conditions and the product desired determines the most economical means of heating in every case. Often the most expensive source of heat pays for itself in better products and better working conditions. We are here thinking more especially of a small plant where steam is available.

Every industrial plant of any size has something requiring steam heat. Thus a steam boiler is installed to take care of the building heating and such other processes for which steam is necessary. Summer operation is then required of the boiler at lower efficiency to fulfill a few minor operations. If a proper survey were made, many other operations could be found where steam heat could be applied, and thus increase the efficiency of the boiler and eliminate more expensive methods of heating.

When all the processes requiring heat, not to exceed 325 deg. F. for 150-lb. steam pressure, are connected to the boiler the problem of supplying coal, gas or fuel oil to the boiler can be determined by the price of each in the locality of the industrial plant.

When temperatures above 325 deg. F. are desired, they may be supplied by either gas or electricity, depending on the nature of the operation and location. It must be distinctly understood that electrical heat in isolated places for lower temperatures can often be used most economically. Electrical heat is very dependable and is well adapted where a superior product can be made through accurate temperature control.

Recently developed methods of steam heating drying ovens are brought out by the use of a type of unit heater whereby steam at 150 lb. pressure supplied to these heaters will produce an oven temperature of from 325 to 350 deg. F. The oven may or may not be of the conveyor type. If it is a conveyor-type oven some special features may be necessary to prevent excessive air circulation. The fumes exhausted from the oven are only in proportion to the fumes given off by the work being done and not as much as would be required when the oven is heated by gas.

After having made a complete survey of the heating requirements of a plant, quite a large percentage will be found that can be done by exhaust steam. Then one can determine the extent of the necessary equipment to supply this exhaust steam and further reduce costs by generating power with the steam before it is used.

WHAT'S NEW IN PLANT EQUIPMENT

Hydraulic Ash Evacuator Designed to Conserve Basement Space And Give Clean Ash Removal

AN ASH-DISPOSAL SYSTEM which makes it possible to reduce the usual power plant basement depth to one-half or more, with proportionate saving in cost of building and at the same time removes the ashes without dust or fumes, giving a clean basement, is announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The entire system is closed, and the ashes are under water until they are shot out of the discharge pipe.

Ash, cinder, and clinkers pass from the lower end of the furnace to a pair of submerged clinker-grinding rolls, are crushed to suitable size, and sink into a dump or ash pit of concrete or cast iron. From its bottom they are at intervals swept by a high-velocity water jet in an ejector nozzle, and ashes and water are discharged through a pipe line to a considerable distance, or even to a higher elevation. The entire operation can be made automatic, with no manual labor, and it is claimed that four to five tons of ashes a minute can be removed by a relatively small amount of water, at about 100-125 lb. pressure, which can often be taken from the plant's regulation fire pump, requiring no especial water supply.

A typical arrangement of the evacuator is shown. It comprises a water-filled ashpit, sluice gate, ejector and discharge line. The diverging sides and concave bottom prevent arching of the material at any point. The bottom is stepped upward from the discharge opening to secure maximum agitating and cleaning effect from the nozzles. The ashpit outlet is controlled by the hydraulically operated sluice gate. Except when evacuating ash, the ashpit is always filled with water. This provides an effective seal against the infiltration of air or the emission of gas and air at the clinker grinder rolls. This seal feature is easily obtained on new installations by establishing the level of the water in the ashpit so that the clinker grinder rolls are completely submerged. The submerging of the rolls also protects them from overheating and helps to disintegrate and soften the clinker and refuse before it is actually ground through them. This water level is fixed by the overflow and seal trap as shown.

Located adjacent to the sluice gate is the ejector. It comprises a special fitting to connect the 20-in. sluice gate line to the 12-in. discharge line through a 90-deg. angle. Within this special fitting is the high velocity water ejector nozzle or nozzles. The ashpit water, with its entrained ash, passes through the sluice gate and is picked up by the high-velocity water jet, which propels the mixture through the discharge line to the ash dump. The design of the ejector nozzles is influenced by two factors—the length of discharge line and the elevation of its end above the ejector level.

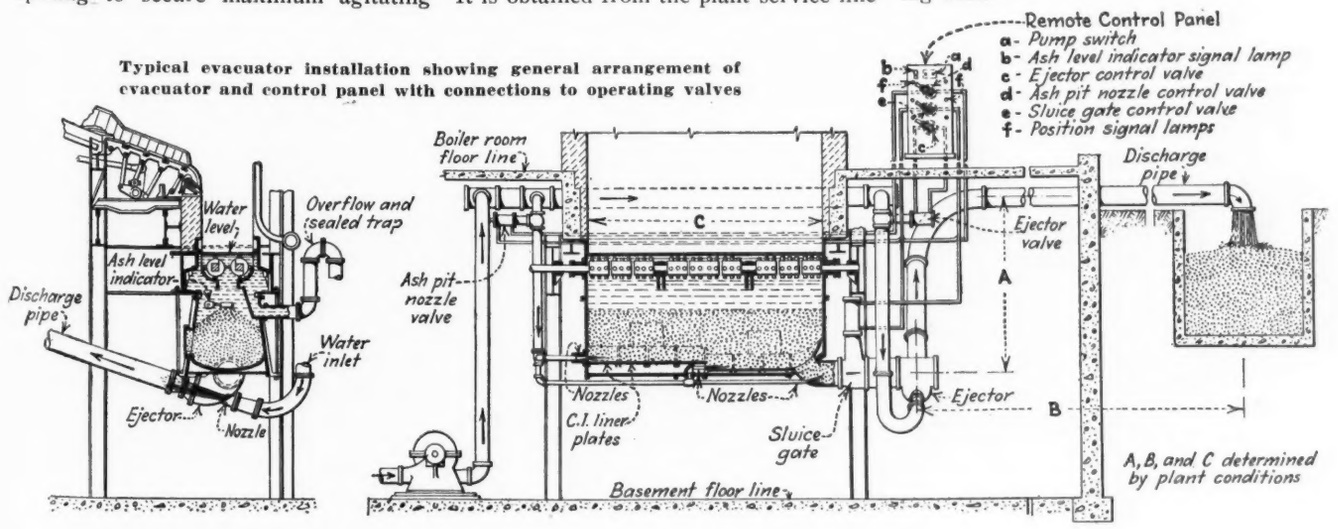
Clear water for the ejector is supplied under a pressure of approximately 125 lb. (according to nozzle design). It is obtained from the plant service line or from a separate pump. This pump, with the Fire Underwriter's approval, may also constitute the regulation fire pump for the plant. No pump for handling ash and water mixtures is required in connection with the evacuator.

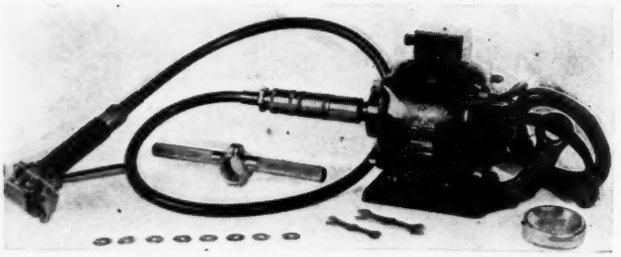
The discharge line is made of 12-in. cast-iron pipe suitable to withstand a pressure of 150 lb. On account of the ash and refuse being thoroughly entrained in the water, only a small proportion of it comes in contact with the surface of the pipe, which reduces the wear on the pipe line.

The control for the evacuator may be either manual or automatic, at a convenient point remote from the apparatus itself. For evacuating the ash and refilling the ashpit with water, definite control sequence is required. For manual operation the six steps or functions are accomplished by three four-way valves mounted on the control panel with position lights. Automatic operation is accomplished by a motor-operated controller and its master valve.

A rather unique device to determine when the ashes fill the pit forms the basis of the control. It is called the "ash level indicator" and consists of a moving vane or paddle. Motion is imparted to it from the clinker grinder driving mechanism through a lost-motion linkage. As the moving paddle encounters a rising ash level the lost motion is gradually absorbed until in the limiting position a contactor is operated. If manual control is used a signal lamp lights, indicating that the pit is filled. The operator then manipulates the control valves in proper sequence, as indicated by the position lights on the control panel. The valves are so interlocked as to be inoperative if the proper sequence is not followed. For automatic control the contactor, actuated by the ash level indicator, starts the motor-operated controller which accomplishes the six functions of the control cycle in their proper sequence. With this arrangement the ash and refuse are automatically evacuated whenever the ashpit fills. An important feature of this system is that it obviates the necessity of providing large storage space in the ashpits, which, in turn, decreases building cost.

Typical evacuator installation showing general arrangement of evacuator and control panel with connections to operating valves





Complete Ideal Universal mica undercutter with auxiliary attachments

Aluminum Coating

"PERMITE RESALUM" is the name given to a protective and preservative aluminum coating for use on metal, wood, fabric, stone or any combination of these materials. It is put out by Aluminum Industries, Inc., Cincinnati, Ohio. The coating is said to be heat- and corrosion-resistant.

Mica Undercutter for Small and Large Commutators

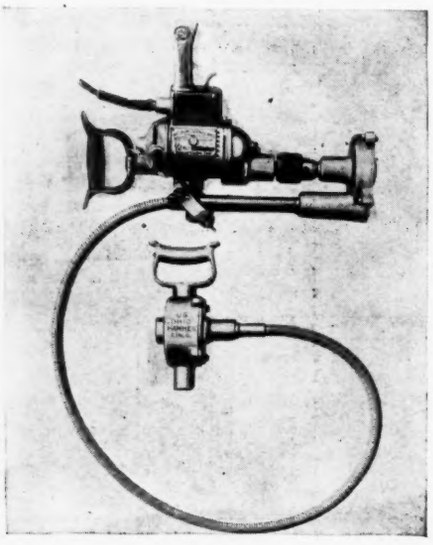
THE 1932 model of the Ideal mica undercutter, illustrated, is designed for use on both small and large commutators and for machines with small clearance between the brush arms. It can be used on a commutator with but $2\frac{3}{4}$ in. clearance without the guide assembly attached or in $3\frac{1}{2}$ in. space with the guide attached. By reason of the small clearance required a wide range of commutators can be handled without the necessity of dismantling the entire brush rigging. Small head and small saw permits cutting to within $\frac{1}{4}$ in. of the riser. Locking micrometer adjustments are provided for depth, width and pitch of slot.

An auxiliary handle, adjustable for right or left hand, is supplied for convenience in holding, and a special handle is also available to facilitate the use of the undercutter in the shop. The machine is supplied with four high-speed steel milling cutters or eight high-speed steel saws. It is put out by the Ideal Commutator Dresser Company, Sycamore, Ill.

Light Weight Electric Hammer

THE LIGHT WEIGHT of the new electric hammer brought out recently by the United States Electrical Tool Company, 2490 West 6th St., Cincinnati, Ohio, is made possible by operating the hammer through a flexible shaft attachment connected with an electric drill.

In addition to the decrease in weight for a hammer of this capacity, it is claimed that the flexible shaft also prolongs the life of the tool by absorbing the destructive jarring otherwise imposed on the power unit. The hammer is designed to give 4,000 blows per minute up to one inch. Ball and roller bearings are used throughout. The weight of the hammer only is nine pounds.



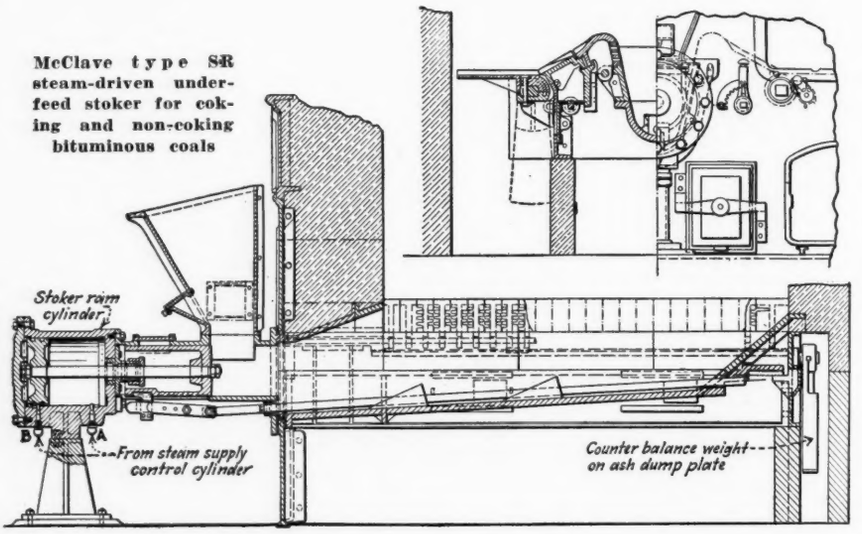
Hammer with flexible shaft and driving unit

New Alloy Steels

A SERIES of low-alloy steels containing chromium, manganese and silicon are now being offered by the Electro Metallurgical Company, 205 East 42d St., New York, N. Y. These new alloys have been introduced under the name of "cromansil" steels, a general term used to designate not one special steel, but all steels whose composition comes within the recommended range of alloy content.

The most useful forms of cromansil steel contain from 0.4 to 0.6 per cent chromium, 1.1 to 1.4 per cent manganese, and 0.7 and 0.8 per cent silicon, with a carbon content ranging from less than 0.10 to 0.65 per cent, depending upon the particular use to which the steel is to be put. The presence of these three elements in combination results in high ultimate strength, great ductility, high fatigue limit and high impact strength and ready machinability.

A few of the applications in which this type of steel is said to be especially advantageous are chimneys, penstocks, pressure vessels, tanks, boilers, stay-bolts and high-strength seamless tubing.



McClave type SR steam-driven underfeed stoker for coking and non-coking bituminous coals

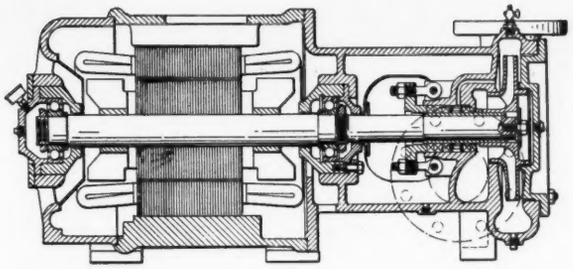
Steam Drive Underfeed Stoker for Bituminous Coals

A RECENT ADDITION to the line of coal-burning equipment put out by McClave-Brooks Company, Scranton, Pa., is Type SR steam-driven underfeed stoker illustrated. The stoker is designed for burning coking and non-coking bituminous coal and for use under boilers up to 3,000 sq.ft. of heating surface.

A specially designed poppet valve steam control regulator with forced-feed lubrication controls the speed of the stoker and gives a sufficiently wide range of speed to meet practically any load condition. The grate surface is made up of replaceable tuyère blocks with staggered mesh to prevent sifting and to give uniform air distribution. The grate bars located between the tuyères and ash-dumping plates are of sectional rabbeted design. Adjustable dampers are provided for controlling the air to the retort tuyères, grate bars and ash-dump plates, thus providing air control over the entire fuel bed.

Self-Contained Motor-Driven Single-Stage Centrifugal Pump

IN THE Class LS single-stage centrifugal pump now being put out by the Pennsylvania Pump & Compressor



Cross-section of Pennsylvania Class LS single-suction enclosed-impeller centrifugal pump

Company, Easton, Pa., the pump and driving motor form a compact self-contained unit with one shaft serving both the pump and motor. The shaft is carried in two ball bearings and is protected at the impeller end by a bronze sleeve which extends beyond the packing gland.

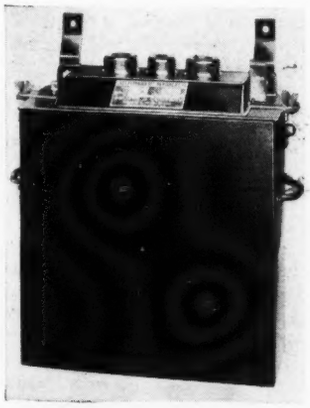
The impeller is of the single-suction inclosed type and is mounted with the suction side facing the motor. Suction and discharge openings of the flanged type form an integral part of the pump casing. This construction permits ready access to the interior of the casing and impeller without disturbing any piping.

Sizes available range from 1½ to 4 in., with capacities up to 700 g.p.m. and heads up to 75 and 85 ft. at 1,750 revolutions per minute.

Explosion-Proof Starter for Hazardous Locations

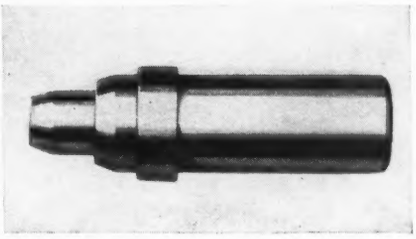
CLASS 8528 explosion-proof alternating-current automatic starters manufactured by the Industrial Controller Division of the Square D Company, Milwaukee, Wis., for use in hazardous locations, are of the oil-immersed type and control across-the-line single and polyphase motors. The ratings are from 5 to 50 hp. for 220 volts and from 7½ to 75 hp. for 440- and 550-volt circuits.

The starter consists of a cast-iron head, welded steel tank and starter panel. The panel carries a three-pole magnetic contactor and two oil dashpot overload relays. A visible gage indicates the maximum, normal and minimum oil level in the tank. The oil, in which the terminals and electrical parts are immersed, will prevent an arc passing to the surrounding fumes and gases.



Explosion-proof starter for Class 1, Group D locations

Tip adaptor for use on Purox No. 11 welding torch

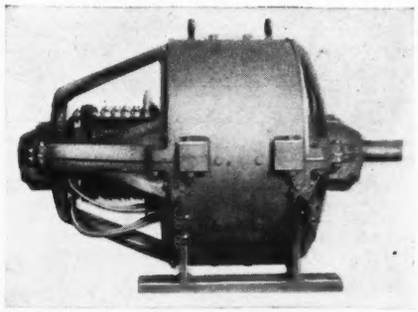


Welding Tip Adaptor

BY MEANS of the tip adaptor illustrated it is now possible to use the stems and tips of the Purox No. 00-D welding torch and the stems and tips of the Purox No. 00 welding and lead-burning torch on the Purox No. 11 welding torch, thus enabling a welder who has only an occasional light welding job to use the correct welding tips for this small work. It is put out by the Linde Air Products Company, 30 East 42d St., New York City.

Direct-Current Motors

LARGER MOTORS for its Type T direct-current line have been announced by the Reliance Electric & Engineering Company, 1088 Ivanhoe Road, Cleveland, Ohio. The new motors range in size from 100 hp. at 800 r.p.m. to 350 hp. at 1,200 revolutions per minute.



Reliance Type T direct-current motors

A rolled-steel split-frame construction is used, with feet and supporting members of heavy bar steel welded to the frame. There are six main poles and six commutating poles. Brackets and sleeve bearings are of split design. The brushholders combine the advantages of the reaction type with those of the box type. Brush studs are of steel, cadmium-plated.

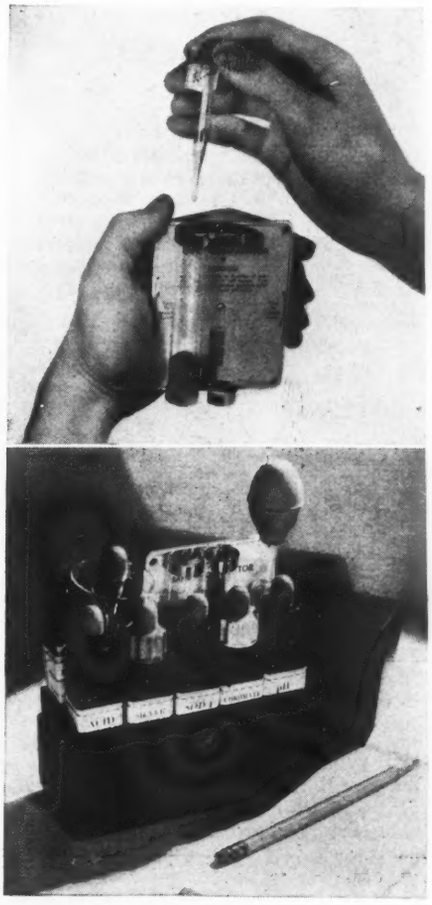
Motors may be supplied for constant-speed or adjustable-speed service with a range 2 to 1 or 3 to 1.

Rapid Test Kit

DEVELOPMENT of a compact kit for the rapid testing of boiler-feed water, processing water, bleaching baths, etc., has been announced by A. Drucker & Company, 1507 East 55th St., Chicago, Ill. The eastern representative of this company is Louis H. Joseph, 840 Broadway, New York City. Among the determinations which can be made with this outfit are included pH values ranging from 3 to 11; hardness of water; and sulphate and chloride content. One of the chief advantages cited for the apparatus is that the system of testing has been very much simplified.

The kit consists of a comparator for making pH determinations by the colorimetric method, a pipe and test tube for measuring and holding the solution to be examined, funnel, filter paper, the necessary indicators and reagents, and an instruction book. The reagents are supplied in non-leakable, bakelite-top dropper bottles. Specially designed droppers are employed, which deliver a drop representing one grain per gallon, thus eliminating the need of burettes in making titrations.

The color standards employed in the pH determination are reproduced from 5 c.c. buffer solutions and were matched in daylight. Pigments were selected to withstand fading. It is stated that end points are easily distinguished and that results are sufficiently accurate for power plant and process control.



Drucker rapid test kit

NEWS of the WEEK

Idaho Power Production Tax Sustained by Supreme Court

CONSTITUTIONALITY of the Idaho tax on power production was sustained May 16 by the Supreme Court of the United States in an opinion unanimously affirming the decision of the district court for the District of Idaho in the case of Utah Power & Light Company vs. Pfost, No. 722. The opinion, written by Justice Sutherland, said in part:

"We are satisfied, upon a consideration of the whole case, that the process of generation is as essentially local as though electrical energy were a physical thing; and to that situation we must apply, as controlling, the general rule that commerce does not begin until manufacture is finished, and hence the commerce clause of the Constitution does not prevent the state from exercising exclusive control over the manufacture."

It had been contended by the power company that the tax is not one on manufacture or production or on the extraction of a product of nature, but on the transfer or conveyance of energy in nature from its source to its place of use, and that much of the energy generated in Idaho is transmitted in interstate commerce.

Emphasizing the point that in the Utah company's system electricity is not stored in advance but produced as called for, the opinion stated that the "process by which the mechanical energy of falling water is converted into electrical energy, despite its hidden character, is no less real than the conversion of wheat into flour at the mill."

The Supreme Court also sustained a section of the Idaho law granting exemption from the tax to electrical energy used for pumping water for irrigation pumping.

"The irrigation of even private lands in the arid region is a matter of public concern," the opinion said, "and an exemption of the character here involved is not precluded by the equal protection clause of the Fourteenth Amendment."

A.E.C. Urges Balanced Budget, Credit Expansion, Public Works

The administrative board of the American Engineering Council, at a meeting in Washington on May 13, adopted a report by its Committee on Governmental Expenditures. Recommendations of the report are:

"(1) That all governmental budgets be promptly balanced—federal, state, municipal and all their sub-divisions. These budgets should be balanced by a courageous and intelligent reduction of governmental expenditures. Taxes should be increased as a last resort when necessary to balance sound and economical budgets.

"(2) That the functions of the Reconstruction Finance Corporation be so broadened that, with proper safeguards, it may make credit more readily available to industry.

"(3) The committee endorses in substance the pending legislation in Congress for the creation of Federal Home Loan Banks. The committee is of the opinion that the effect of this legislation would be to provide, through proper channels and upon liberal terms as to time and interest, the funds necessary to take care of maturing mortgages on many homes and to encourage the building of homes under liberal but financially safe terms.

"(4) Your committee approves in principle a normal program of federal, state and municipal public works construction as an effective and immediate means of increasing purchasing power, stimulating trade recovery and reviving employment.

"(5) Your committee recommends that no governmental public works be undertaken which would essentially be in competition with private business."

A.S.R.E. Spring Meeting in Cambridge, Mass., June 9-11

An interesting technical program and informal, inexpensive entertainment events will feature the nineteenth annual spring meeting of the American Society of Refrigerating Engineers to be held in Cambridge, Mass., from June 9 to 11, inclusive. Headquarters for the meeting will be the Massachusetts Institute of Technology, where rooms may be secured in the dormitories.

Three technical sessions are scheduled, one on each day of the meeting. The papers to be presented include: "The Steam Ejector for Industrial Refrigerating Capacities," D. K. Dean; "The Steam Ejector for Commercial Refrigerating Capacities," R. W. Waterfill; "A Review of Heat Transmission Developments," W. J. King; "The Mechanism of Moisture Absorption in Insulation," A. A. Berestneff; "Low Temperatures and the Rotary Compressor," Harry Sloan; "A Review of Lubrication Technique," B. L. Newkirk; and "The Control of Solid CO_2 Refrigeration," J. G. Bergdoll and A. W. Ruff.

COMING MEETINGS

American Society of Mechanical Engineers—Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting, Pennsylvania State College, June 8-11. C. W. Rice, 33 West 39th St., New York.

American Institute of Electrical Engineers—Cleveland, Ohio, June 20-24. Headquarters, 33 West 39th St., New York.

American Society of Refrigerating Engineers—Massachusetts Institute of Technology, Cambridge, Mass., June 9-11. D. L. Fiske, 37 West 39th St., New York.

National District Heating Association—William Penn Hotel, Pittsburgh, Pa., June 14-17. D. L. Gaskill, Greenville, Ohio.

National Electric Light Association—Atlantic City, N. J., June 6-10. A. J. Marshall, 420 Lexington Ave., New York.

Smoke Prevention Association—Royal York Hotel, Toronto, Ont., Canada, June 7-10. Frank A. Chambers, City Hall Square Building, Chicago.

A.S.M.E. Announces Course In Lubrication Engineering

A complete course of instruction for the training of lubrication engineers will be issued soon by the American Society of Mechanical Engineers. Prepared by the Lubrication Engineering Committee of the society's Petroleum Division, the course will deal with the fundamentals of lubrication and the application of lubricants to all classes of machinery. It will also explain testing of such machinery to determine if the most effective lubricants have been used and indicate how a correction of the application systems can be applied to bring about the highest degree of economy with the lowest possible cost for power and maintenance.

The course is being issued in response to the many requests recently received by the A.S.M.E. for information on lubricants and bearing testing machines and special data regarding the lubrication of advanced types of all classes of machinery. In preparing the course a study is being made of the losses now taking place in the operation of such machinery so that there can be selected in a practical manner the lubricants which will, for each individual plant conditions, give the most desirable results.

The report on this study is being written and revised by the leading experts in the petroleum and allied industries, and is being reviewed by the chief lubrication engineers of the important lubricating oil companies. It is in the last stages of preliminary writing and after acceptance by various trade association will be made available through the society.

New Hydraulic Laboratory Opened at Montreal School

One of the finest hydraulic laboratories in Canada, that of the Polytechnic School, Montreal, was inaugurated on May 10, in the presence of many prominent engineers of the city and province.

The new laboratory occupies two floors. The lower is 87 ft. long by 38 ft. wide; the upper floor measures 45 ft. in length by 45 ft. wide. Space is reserved for a flume 5 ft. wide by 4 ft. deep by 150 ft. long. The laboratory is intended primarily for teaching purposes; it will, however, lend itself to a limited amount of thesis and research work. It was planned after collecting much data on the present-day practice in both the German and United States laboratories.

Practically all the water required will be pumped and recirculated through the various apparatus. Three storage reservoirs have been built in an existing basement, and will serve as wells for the pumps. Direct connections with the city mains have been provided, however, and may be used for experiments requiring a small quantity of water under low pressure. The demonstration room is equipped with a small wooden glass-sided flume, pressure tank, cross-sectioned boards and other necessary apparatus for demonstrating experimentally the different principles of hydraulics.

Electrical Manufacturers Adopt Swope Employment Program

The unemployment plan advocated by Gerard Swope, president of the General Electric Company, was sanctioned by the National Electrical Manufacturers Association at its spring meeting in Hot Springs, Va., May 16.

Acting upon a report of the Committee on the Swope Plan, appointed in New York last September, the Policies Division of the association adopted what is officially designated as the "Nema Mutual Unemployment Benefit Plan," embracing, it was declared, the first concrete measures taken by a body of manufacturers to meet this obligation of employers to employees. The Nema plan, in accord with the proposals of Mr. Swope (see *Power*, Sept. 22, 1931, page 439), ignores the dole, and recognizes the principle of mutuality, both employers and employees contributing to a common fund.

The Nema plan is applicable in normal times to 200,000 workers. The National Electrical Manufacturers Association has 300 member companies with a total output comprising from 85 to 90 per cent of the purely electrical product of the country. The Policies Division is composed of one representative from each member company. The chairman of the division is former Governor J. H. Trumbull of Connecticut, who is also president of the association.

Economic Planning Topic of N.A.P.A. Meeting in Detroit

Many phases of present-day economic planning will be discussed by leading economists and industrial executives at the seventeenth annual convention of the National Association of Purchasing Agents, which will be held at the Book-Cadillac Hotel, Detroit, Mich., from June 6 to 9, inclusive. General and group business sessions, the "Inform-a-Show" and social events are features of the program.

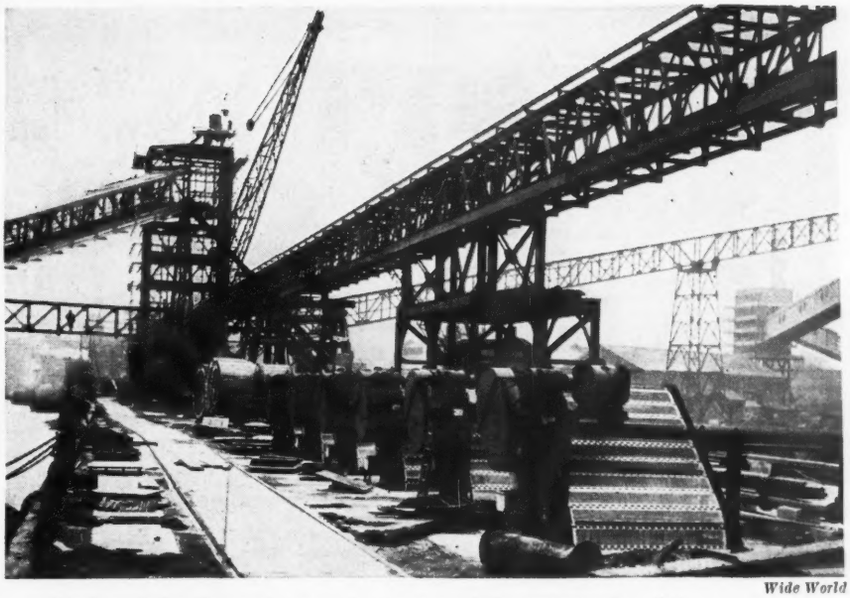
The addresses include: "Implications of Economic Planning," Wallace B. Donham, Harvard University; "Relation of Research to Planning," Charles F. Kettering, General Motors Corporation; "Self Regulation by Industry," Charles F. Abbott, American Institute of Steel Construction; "Purchasing Problems as Affected by Economic Planning," Donald G. Clark, Brown & Sharpe Manufacturing Company; "An Evaluation of Economic Planning, Particularly as It Affects the Work of the Purchasing Agent," E. C. Robbins, Harvard University; and "Should the Anti-Trust Laws Be Modified?" Charles W. Dunn, Abram F. Myers and Henry W. Beer.

Three Killed Razing Power Plant Stack in Cleveland

Three of eight men working on the demolition of a 210-ft. concrete stack of the Cleveland Electric Illuminating Company were killed May 11 when the scaffold upon which they were working gave way. The three killed were thrown from the scaffold to a spoil hopper located inside the base of the stack 188 ft. below the working level. The other five were able to hang on long enough to work their way around to the steel ladder on the outside of the stack. The stack is one of three being torn down. One stack, built identically with the one where the fatal accident occurred, has been taken down a distance of about 100 ft. The work is being done under contract by the Great Lakes Dredge & Dock Company, and the method of demolition had been approved by the state industrial commission.

According to a report made by George W. Helling, structural inspector of Building Commissioner William Guion's staff, city of Cleveland, the men were working on a scaffold built up of 4-in. planking supported on two 6x6-in. timbers. The scaffold was held by double strands of ¾-in. steel cable running through the timbers and planking and up to four U-hooks hooked over the top of the wall. The hooks are of 2x1½-in. plow steel, and their outside ends ran down the outside of the stack to about the working level of the platform on the inside.

Just what caused the accident cannot be determined until an inspection of the top of the stack can be made.



Wide World

Steel work for the coal conveying system of the 400,000-kw. Battersea power station, now under construction in London. The coal washers may be seen in the foreground. Scheduled for operation this year, the initial installation comprises two 65,000-kw. 1,500-r.p.m. turbine-generators, the largest units in England

Engineering Education Society Joins A.E.C.

Final arrangements have been completed whereby the Society for the Promotion of Engineering Education becomes a member organization of the American Engineering Council. The S.P.E.E. is the foremost exponent of engineering education in the United States. Its membership totals 2,274, composed largely of teachers and professors in engineering colleges. The society will have an important part in the work of the A.E.C., as many problems of concern to the engineering profession which are acted upon by the council involve intimately the future of engineering education. Dean F. L. Bishop, of the University of Pittsburgh, has been chosen by the society as its first delegate to the A.E.C. assembly.

PERSONALS

CHARLES LEMAISTRE, secretary of the International Electrotechnical Commission and director of the British Standards Institution, was tendered a luncheon May 11 at the Engineers' Club, New York City, by members of the I.E.C. United States National Committee and the American Standards Association. Mr. LeMaistre is spending a few weeks in this country following a seven months' tour of Australia, New Zealand and Canada in connection with standardization activities.

GERARD SWOPE, president of the General Electric Company, was awarded a gold medal by the National Institute of Social Sciences on May 12 "in recognition of his public service in formulating the Swope plan for stabilization of industry with a guarantee of employment."

• MARCEL GARSAUD, member of the Federal Power Commission, is visiting water-power projects and sites in the Southeast.

DR. F. HERBERT SNOW, chief of the bureau of engineering of the Public Service Commission of Pennsylvania, has retired after 27 years in the service of the state. Dr. Snow has been head of the engineering bureau since the formation of the commission in 1913.

Gilbert E. Ryder Dies

Gilbert E. Ryder, vice-president of the Superheater Company, New York City, died May 17 of a heart attack. Born in Minneapolis 51 years ago, Mr. Ryder studied at the University of Wisconsin and the University of Illinois. He had been associated with the Chicago, Milwaukee & St. Paul Railroad; the United States Geological Survey, with which he was a fuel conservation expert; the City of Chicago; and was associate editor of the *Railway Review* before joining the Superheater Company.

How's Business?

So far this month there has been no marked change for the worse in the picture of production and trade as a whole, according to *The Business Week*, May 25. Most measures of business activity, as distinguished from security market and financial sentiment, have in fact made a bit better showing in the first half of May than in the last half of April and seem to be reaching some sort of stabilization basis. Steel production shows a slow but steady unseasonal rise which reflects moderately increasing automobile output and is expected to continue well into the summer. Building contracts have improved so far in May contrary to seasonal expectations, due solely to public construction which now exceeds private and has become the main reliance of the industry.

Utility power production for the week ended May 14 was 1,436,928,000 kw.-hr., 13.1 per cent under that for the corresponding period of last year, the N.E.L.A. reports.

BUSINESS NOTES

PYLE-NATIONAL COMPANY, Chicago, Ill., has acquired as a subsidiary the Electro Chemical Engineering Corporation, New York City. The same personnel will be retained in the subsidiary organization, the company states.

CITY OF LITCHFIELD, Minn., has just issued the annual statement on its light, power, heating and water plant, for the fiscal year ended April 4, 1932, showing gross earnings of $102,537.51 and a net profit of $40,535.69. Total output of the electric plant for the year was 2,021,600 kilowatt-hours.

A. LESCHEN & SONS ROPE COMPANY, St. Louis, Mo., is celebrating its 75th anniversary this year. Established in 1857, the company has sponsored many basic improvements in the production of wire rope.

HENRY B. NEWHALL CORPORATION, New York City, and its several divisions—Diamond Expansion Bolt Company, Newhall Chain Forge & Iron Company and New Jersey Foundry & Machine Company—have moved their offices, stockrooms and warehouse to 48 West Broadway, New York City.

LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, announces the appointment of the Great Northern Tool and Supply Company, with headquarters in Billings, Mont., as distributors for Lincoln products in Montana and Wyoming.

New Bulletins

STEAM SERVICE—An interesting, non-technical description of the growth of central station steam service in New York City is given in an attractive 140-page book issued in commemoration of the 50th anniversary of the New York Steam Corporation, 280 Madison Ave., New York, N. Y. With many human touches, the book tells the story of the early struggles and subsequent expansion of the service into the largest system of its kind in the world. Beautiful drawings and photographs add much to interest of the story, and it is rather too bad that credit for the photography was not given somewhere in the book.

LUBRICANT TESTER—The construction and many uses of the Timken wear and lubricant tester are described in a new illustrated booklet of the Timken Roller Bearing Company, Canton, Ohio. Practical suggestions on how to conduct the tests are given in one section of the booklet.

OIL SEALS—Aetna Ball Bearing Manufacturing Company, 4600 Schubert Ave., Chicago, Ill., has just issued a booklet entitled "They Shall Not Pass," which gives sizes, dimensions and data on the applications of oil seals.

New Plant Construction

Compiled by the McGraw-Hill Business News Department, Which Is Prepared to Furnish a More Complete Daily Service to Those Who Wish It

Calif., Sunnyvale—Bureau of Yards & Docks, Navy Department, Washington, D. C., awarded contract for boiler plant improvements to F. W. Snook Co., 596 Clay St., San Francisco. $84,627.

Colo., Colorado Springs—City awarded contract for a 5,000 kw. steam turbine to Elliott Co., Frick Bldg., Pittsburgh, Pa. $69,480; also 6,000 ft. surface type condenser to Ross Heater & Manufacturing Co., 1407 West Ave., Buffalo, N. Y. $10,790.

Ill., Chicago — Sonora Manufacturing Co., 2613 Milwaukee Ave., plans construction of a 5,000 watt television broadcasting station including towers, power station, etc. Private plans.

Ill., Rock Island—U. S. Engineer Office, War Department, Washington, D. C., will receive bids until June 1 for furnishing and installing lock operating and power house machinery, electric power and control system for Dam No. 15 on Mississippi River.

Ind., Berne—City will receive bids until July 1 for construction of a sewage treatment plant including pumping station, tank, etc. Estimated cost $35,000. Charles Brossman, c/o Chamber of Commerce, Indianapolis, is engineer.

Ind., Fort Wayne—Board of Public Works, S. S. Snyder, Secy., awarded contract for construction of a new boiler room including three boilers, at city light plant on Clinton St. to Max Irmscher & Sons, 1113 First National Bank Bldg., $123,588.

Ind., Greencastle — Depauw University, will receive bids until May 24 for alterations and addition to heating plant including boiler and stoker, smoke stack, etc. Estimated cost $40,000. Bevington & Williams, Indianapolis, are engineers.

Ind., Indianapolis—Department of Conservation, will build a waterworks pumping plant and water mains at Turkey Run Park near Marshall. Estimated cost $15,000. Charles Brossman, c/o Chamber of Commerce, is engineer.

Ia., Atlantic—City Council, T. E. Nichols, Clk., having preliminary plans prepared for extensions and improvements to waterworks including new boilers, electric distribution system, watermains, etc. Estimated cost $35,000. Private plans.

La., New Orleans — Sewerage and Water Board, awarded contract for one Vertical screw pump, Cont. 109W. to Bessemer Foundry & Machinery Co., Bessemer, Ala.; induction motor and accessories and one d.c. generator and accessories Cont. 110W., to Fairbanks Morse Co., 1000 St. Charles St., New Orleans, La., and two steel riveted discharge pipes to Chicago Bridge & Iron Works, Electric Bldg., Houston, Tex. $16,144.

Minn., Waconia—City will receive bids until May 31 for construction of a municipal light and power plant and distribution system. Estimated cost $25,000.

Mo., Osceola—City plans an election June 3 to vote $30,000 bonds for construction of a municipal light and power plant, distribution system, etc.

Mo., St. Louis—Board of Public Service, 208 City Hall, will receive bids until June 14 for greenhouses, boiler room and complete heating system in Forest Park. Estimated cost $38,000. F. Updegraff, 329 Municipal Courts Bldg., is engineer.

N. J., Jersey City—M. C. Provision Co., 414 Hoboken Ave., will soon award contract for a 1 story addition to refrigeration plant. Construction Service Corp., 80 Broad St., Elizabeth, is architect. Bids May 23.

N. J., Jersey City—Pennsylvania R.R. Co., Pennsylvania Station, New York, N. Y., completed plans for alterations to ice plant including new ice elevators, etc., at Harsimus Cove Yard here. Estimated cost $40,000. A. C. Watson, New York, is chief engineer. Work will be done by separate contracts under the supervision of Fruit Growers Express Co., Munsey Bldg., Washington, D. C., lessee.

N. Y., Jamaica — Daniel Kaufer, 113-10 Sutphin Blvd., having plans prepared for a 1 story, 40 x 100 ft. market building including refrigeration plant at Sutphin Blvd. and 119th Ave. L. Danancher, 149-14 Jamaica Ave., is architect.

N. Y., Brooklyn—H. Hesterburg, Pres. Brooklyn Borough, Borough Hall, received low bids for construction of a sewage pumping station complete including mechanical and electrical equipment, piping, etc., at Flatlands Ave. and Paerdegat Basin.

Okla., Ada—J. A. McCurley, El Reno, will build a 1 story, 44 x 60 ft. ice plant including loading dock on Main St., here, by local labor.

Ore., Salem—Board of Control, Capitol Bldg., received no bids for construction of complete power plant building including installation of Diesel electric generating plant and electrical distribution system at Penitentiary. $150,000. Bids May 12.

Texas—Cardinal Oil Co. and Phillips Petroleum Co., San Angelo, plan building a 15 mile pipe line from field to Fort Stockton, also constructing loading rack and pumping station at Fort Stockton.

Wash., Seattle—Board of Public Works, will soon award contract for intercepting sewage ssytem including two pumping plants, pipe, etc. Estimated cost $100,000. D. W. McMorris, Seattle, is engineer.

Ont., Windsor—A. S. Boyle & Co., 907 Elliott St., will soon receive bids for construction of a 3 story, 60 x 140 ft. pharmaceutical products plant including 25 x 70 ft. boiler plant at College and Campbell Aves. Estimated cost $150,000. Pennington & Boyde, Security Bldg., are architects.

Iraq—Iraq Petroleum Co., Ltd., London, England, plans 1300 mi. of pipe line from Kirkuk in Iraq, to Haditha where it forks, one to branch through British territory and through Palestine to Haifa, other through French territory of Syria to Tripoli involving 150,000 ton steel pipe; 50,000 ton (about 350 mi.) of pipe awarded to Stewarts & Lloyds, London. Pumps and engines not yet purchased; construction equipment, housing facilities, telephone and telegraph lines and transportation equipment largely unplaced to date.

N. D., Williston—City awarded general contract for waterworks improvements to Western Construction Co., Williston, N. D.; pumping equipment to Allis-Chalmers Co., West Allis, Wis.; filter equipment to E. W. Bachrach, 217 Rialto Bldg., Kansas City, Mo., and clarifier to Dorr Co., 247 Park Ave., New York. $67,153.

Spain—Department of Communication, c/o Government Madrid, plans construction of radio broadcasting stations at Madrid, Seville and Valencia, also series of relay stations including towers, power stations and radio equipment. Estimated cost $500,000.

Equipment Wanted

Boilers and Fuel Burning Equipment — Augusta, Ga.—U. S. Veterans' Bureau, L. H. Tripp, Chief of Construction, Washington, D. C., will receive bids until June 7 for new boilers and fuel burning equipment for Veterans' Hospital here.

Electric Light and Power System—New York, N. Y.—Board of Transportation, J. H. Delaney, Chn., 250 Hudson St., will receive bids until May 27 for furnishing and installing electric light and power system for Concourse shops and yard of Independent System of City-owned Rapid Transit Railroads.

Oil Burners—Brookline, Mass.—Board of Selectmen, will soon receive bids for oil burners for municipal power plant. Estimated cost $27,000.

Pump—South San Francisco and Eureka—Public Works Officer, Mare Island, Navy Yard, will receive bids until June 1 for furnishing and installing booster pump, piping, etc., at U. S. Naval Direction Finder stations here. Spec. 6909.

Pump—Friend, Neb.—City, G. A. Dreher, clk., will receive bids in June for turbine pump in connection with waterworks.

Pump—Mayville, N. D.—Selmer Groth, City Auditor, will receive bids until June 6 for one 350 g.p.m. centrifugal pump for filtration plant.

Pump and Motor—Mayville, N. D.—City will receive bids until June 6 for centrifugal pump direct connected to 220 v. 60 cycle a.c. electric motor in connection with waterworks.

Pumping Equipment—Saratoga, N. Y.—Common Council, will receive bids about June 15 for new electric pumping equipment for water department. $15,000.